Iron and Steel Engineer

J. F. KELLY, Editor

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COMING MEETINGS AND PAPERS

PHILADELPHIA DISTRICT SECTION

Saturday, April 7th, 1928 — **Engineers Club** — **Philadelphia, Penna.**

GENERAL IDEAS AND DISCUSSIONS

"The Three F's of the Electrical Industry," by D. M. Petty, Electrical Supt., Bethlehem Steel Company, Bethlehem, Pa.

"Application of Across the Line Starters for Induction Motors," by P. T. Vanderwaart, Elec. Engr., New Jersey Zinc Co., Palmerton, Pa.

"Recuperators, With Special Reference to Those Used on Forge Furnaces," by A. E. Walden, of Wehr & Walden, Engrs., Baltimore, Md.

"Automatic Priming Pumps," by N. C. Bye, Mechanical Engineer, Henry Disston & Sons, Philadelphia, Pa.

"Air Conditioning Equipment," by W. H. Burr, Supt. Elec. Dept., Lukens Steel Company, Coatesville, Pa.

CHICAGO DISTRICT SECTION

Tuesday, April 24, 1928 — **Electric Power Club** — **30 North Dearbon St. Chicago, Ill.**

"Water Cooled Furnaces," by Mr. Martin Frisch, Combustion Engineering Corporation, New York, N. Y.

BIRMINGHAM DISTRICT SECTION

Saturday, March 31st, 1928

"The Invisible Relay in Vari-Time Control," by W. H. Williams, Vice President, Clark Controller Company, Cleveland, Ohio.

Saturday, April 28th, 1928

"Waste Heat Boilers," by J. B. Crane, Engineer, Combustion Engineering Corporation, New York, N. Y.

Thursday, March 29th — **PITTSBURGH DISTRICT SECTION** — **Pittsburgh, Penna.**

"Inspection Trip, Edgar Thomson Works, Carnegie Steel Company, Braddock, Pa." Auspices of Combustion Engineering Section. (See page 143 of this issue for particulars.)

CLEVELAND DISTRICT SECTION

April, 1928

Structural Steel Welding, Lincoln Electric Co., Cleveland, Ohio.

There will be an inspection trip to Lincoln Electric Company the same day.

EDITORIAL

SALVAGE OF STEEL PLANT EQUIPMENT BY WELDING

By A. J. STANDING*

The successful operation of Steel Plants in the face of declining prices and tonnage demands the closest consideration of all elements which enter into the ultimate cost per ton of product. Many of these items are not readily controllable but are more or less resultants of trade conditions and geographical locations of plants while other items of cost are directly amenable to proper methods of regulation.

One of these items of expense is the gradual deterioration of equipment and the constant drain on earnings caused by the setting up of replacement funds. The importance of this feature fully warrants the most careful study of all methods which have as their objective the preservation of equipment with a view to lengthening its active working life of economic usefulness to the plant operation. In some industries the realization of this problem has led to the establishment of a reclamation department under the supervision of an engineer who must be qualified to pass on all questions as to the economic advisability of recovery and repair of all apparatus before it can be scrapped and replaced. Such a department has at its command many modern methods of salvage that are of value under certain conditions to which each method may be most adaptable. The determination of the best method in each case is governed by certain factors that must receive careful attention in order to arrive at the correct solution of each problem.

It has always been the custom to patch and repair broken equipment; but today we must go farther than that. We must so improve our repair and salvage methods that we are able to return the equipment to service virtually as good as new and at a reasonable cost.

The one general agency employed to this end is welding; using the term in its broad meaning to cover all methods of reuniting and building up broken or worn pieces of equipment. The history of welding dates back to the forges of antiquity and from the earliest times the art of welding metals has been clothed with an air of mystery. We can all remember the special skill of the blacksmith who could make good reliable welds as compared to others who never quite seemed to get the knack of making a perfect weld. There was a certain indefinable ability that could not be readily explained.

Welding has recently been in the spotlight of attention from so many different angles that gradually we find this cloud of mystery being dissolved and welding emerging on a basis of facts and predetermined accomplishments. Probably no single cause contributed so much to the rapid advancement of the art of welding as did the World War with its demands for both new and repaired equipment to be turned out in record breaking time. It was in response to this demand that welding was made the object of scientific engineering research which has developed its possibilities as a commercial tool of inestimable value in production and reclaimation work.

When we turn to welding as the logical answer to our repair problems we must avoid the not uncommon mistake of thinking we have discovered a panacea for all our troubles; because we may run counter to sound engineering practice in our endeavor to apply welding to every case. If we go to great lengths in establishing a welding research department, we may so increase our costs by additional overhead and man hours that the savings may be entirely swallowed up in the very costs of salvage, resulting in ultimate loss. The saner way to approach this problem is by gradually extending the sphere of knowledge and responsibility of our existing repair men so that they will come to a realization of the possibilities which the various welding methods present to them in the course of their regular operation.

The character of welds made by electric-arc, gas-torch and in general by methods based on joining two metallic surfaces by fusion of a third metal, is still to a large extent governed by the skill of the individual operator, notwithstanding that modern equipment has aimed to eliminate his personal skill from the problem.

The correct prediction of consistently uniform results by these methods, therefore, first imposes the necessity of securing or of training welders who have demonstrated their ability to intelligently grasp the conditions preceding the welding, the occurrences during the operation and the forces that will act afterwards. We find that in work which requires a tensile or shear test after welding, the characteristics of the welder's work are especially important because the elements of fusion and slag inclusions greatly influence the results of the weld. In the simple building up of worn surfaces, the main problems are again proper fusion to hold the welded metal in place, and also certain consideration of the relative hardness and wearing qualities of the built-up metal as compared with the parent metal, which features often involves a variation in the composition of the welding wire or filling in rods so that a surface may be produced that is equal to or superior in wearing qualities to the original metal. This is particularly true of the building up of worn pods on the wobblers of rolls, pinions, and spindles in mill work where the service involves shocks and friction due to wiping at high surface pressures. It is often necessary to make use of the scleroscope to determine the point at which we are obtaining a satisfactory hardness of welded material. Some plants are welding the treads of crane truck wheels using a high manganese welding wire and grinding the treads to a true size and

(Continued on page 144)

*Elec. Supt., Bethlehem Steel Co., Bethlehem, Pa.

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*Electrical Distributing System and Equipment of the National Tube Co., Gary, Ind.**

By EDWIN L. UPP†

ALL electric current used in the Gary Works of the National Tube Co. is purchased; part from the Gary Works of the Illinois Steel Co. and part from the Northern Indiana Public Service Co.

Current from the Illinois Steel Co. is brought to our plant over two 6600 V., 3 phase, 25 cycle lines, each consisting of 5-4/0, 3 conductor lead covered paper insulated cables tested for 15,000 V. carried in 3½" fibre ducts imbedded in concrete. These lines are connected to a single distributing bus in our Continuous Skelp Mill Motor Room through reactors and 1200 ampere truck type oil circuit breakers of 52,000 amperes rupturing capacity. The manholes along these lines are so constructed that each line is separated from the other by a nine-inch concrete wall, making it possible at any time to kill one line for inspection, repair or changes and enable work of this nature to be done without sending men into manholes carrying live conductors.

*Presented at Chicago Section, October, 1927.

†Elec. Superintendent, National Tube Co., Gary, Ind.

The entire system was laid out with this thought in mind, and ducts for parallel lines were run to all points, using high tension current. Unfortunately, however, the Illinois Steel Co. has as yet been unable to supply our entire current requirements so it has been necessary for us to purchase power from the Northern Indiana Public Service Co. and as it has been impossible for us to interconnect the power from the two sources, we have in some cases arranged to carry Public Service Power over one line and Illinois Steel on the other so that in case of temporary failure on either system, we could immediately switch to the other in sufficient quantity at least to keep such machinery moving as was necessary to prevent serious damage to our furnaces or product. Accompanying one line diagram shows our high tension system. Each line and motor lead is equipped with graphic watt meter and integrating watthour meters, as are also all our low tension feeders.

Current from the Public Service Co. is brought to our plant over two 9000 V., 3 phase, 25 cycle

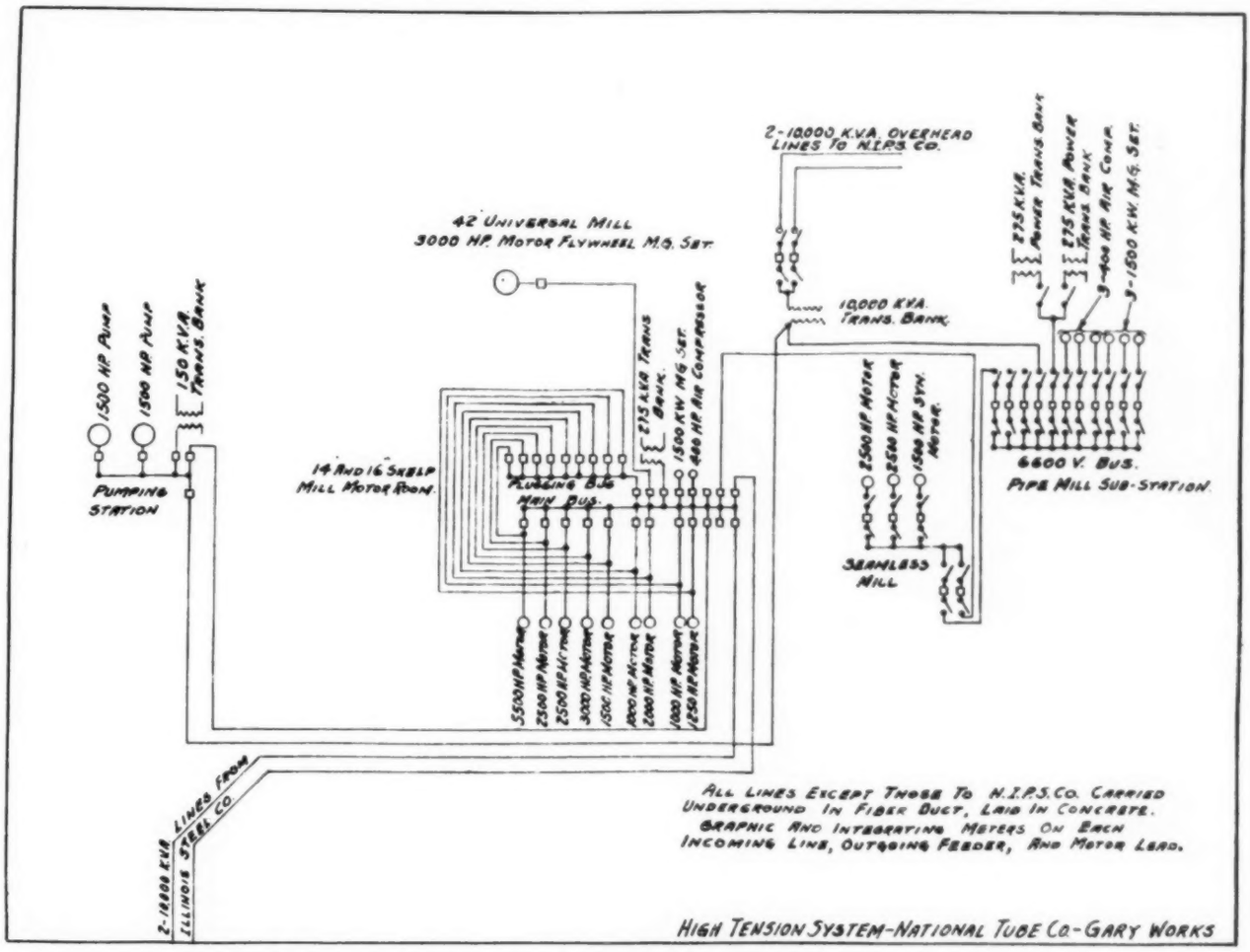

2-10000 K.V.A. OVERHEAD LINES TO N.I.P.S. CO.
42" UNIVERSAL MILL
3000 H.P. MOTOR FLYWHEEL M.G. SET
10,000 K.V.A. TRANS. BANK
1500 H.P. PUMP
1500 H.P. PUMP
150 K.V.A. TRANS. BANK
PUMPING STATION
14" AND 16" SKELP MILL MOTOR ROOM
275 K.V.A. TRANS BANK.
1500 K.W. M.G. SET.
400 H.P. AIR COMPRESSOR
PLUGGING BUS
MAIN BUS.
275 K.V.A. POWER TRANS BANK
275 K.V.A. POWER TRANS. BANK
3-400 H.P. AIR COMP.
3-1500 K.W. M.G. SET.
2500 H.P. MOTOR
2500 H.P. MOTOR
1500 H.P. SYN. MOTOR
6600 V. BUS.
PIPE MILL SUB-STATION
SEAMLESS MILL
3500 H.P. MOTOR
2500 H.P. MOTOR
2500 H.P. MOTOR
3000 H.P. MOTOR
1500 H.P. MOTOR
1800 H.P. MOTOR
2000 H.P. MOTOR
1000 H.P. MOTOR
1250 H.P. MOTOR
2-10000 K.V.A. LINES FROM ILLINOIS STEEL CO.
ALL LINES EXCEPT THOSE TO N.I.P.S. CO. CARRIED UNDERGROUND IN FIBER DUCT, LAID IN CONCRETE.
GRAPHIC AND INTEGRATING METERS ON EACH INCOMING LINE, OUTGOING FEEDER, AND MOTOR LEAD.
HIGH TENSION SYSTEM-NATIONAL TUBE CO.-GARY WORKS

FIG. 1—High Tension System, National Tube Company, Gary Works, Gary, Ind.

lines from frequency changers at their Aetna Sub-Station to an outdoor transformer station on our property, where it is stepped down to 6600 V. and carried in underground ducts to a distributing bus in our Pipe Mill Sub-Station. Line switches at the Pipe Mill Sub-Station are of the same type and capacity as those at the Skelp Mill Motor Room, but are mounted in concrete cells instead of being truck mounted. Current from the Public Service

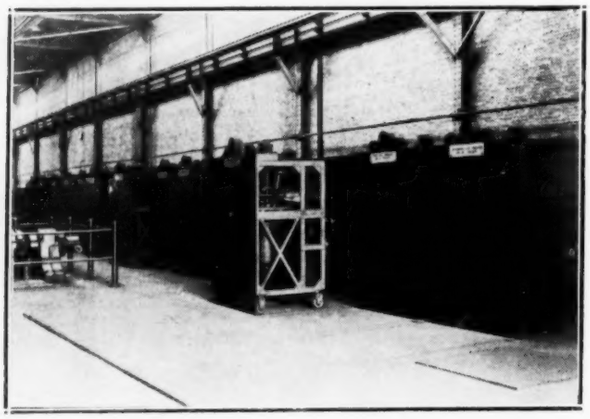


FIG. 2—Truck Type Circuit Breakers, Continuous Skelp Mill Motor Room.

Co. is metered at the low tension side of the static transformers at our outdoor sub-station and by our contract with them, they maintain and assume all responsibility for the 9000 V. line and the 9000 to 6600 V. transformers, although the transformers and that part of the line on the National Tube Co.'s property was constructed and is owned by the National Tube Co. This provision was written into

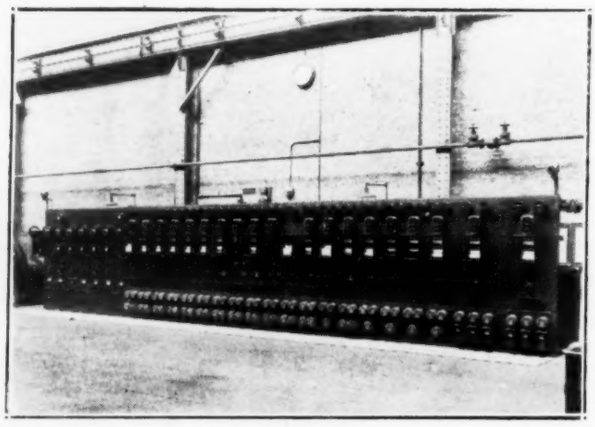


FIG. 3—High and Low Tension Control Panels, Continuous Skelp Mill Motor Room.

the contract so that there might be no divided responsibility for the lines and transformers.

Returning now to the distributing bus in the Skelp Mill Motor Room: Single Feeders are taken from it to the main roll drives in the 14" and 16" Continuous Skelp Mills to the flywheel set furnishing power for main roll drive in the 42" Universal Skelp Mill, to a 1500 KW. synchronous motor-generator set, providing power for 230 V., D.C. auxiliaries, to 6600/220 V. static transformers providing A.C. auxiliary power, and to a 400HP. synchronous air compressor. In addition to these, paralleled lines were originally run to the distributing bus in the Pipe Mill Sub-Station and to the Pump House. Purchase of power from two sources, however, made it necessary to divert one line from Pipe Mill Sub-Station to No. 1 Seamless Mill and one Pump House line has been cut off this bus and run to the outdoor transformer station of the Public Service Co. This arrangement makes it possible to supply either distributing bus, Seamless Mill and Pump House with power from either system.

The main roll drives in the 14" Continuous Skelp Mills consist of 1—2000 HP., 1—1500 HP., 1—1250 HP. and 2—1000 HP. slip ring induction motors and those of the 16" Continuous Skelp Mill of 1—5500 HP., 1—3000 HP. and 2—2500 HP. slip ring induction motors. Each of these motors is connected to the distributing bus through a 52,000 ampere rupturing truck type oil circuit breaker. Breakers of this capacity protect every feeder connected to either the Pipe Mill or Skelp Mill distributing bus. All of these motors are also connected to a plugging bus each through a non-automatic oil circuit breaker

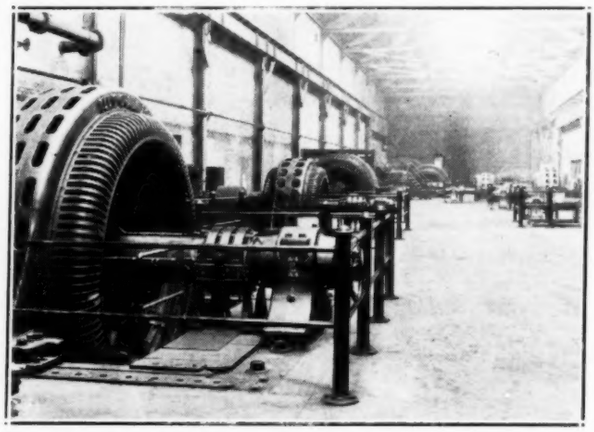


FIG. 4—Continuous Skelp Mill Motor Room.

of smaller rupturing capacity and this entire bus protected by one breaker of 52,000 amperes rupturing capacity. This arrangement having been installed with a view to reducing cost and saving space without sacrifice of protection in case of short circuit.

At the terminals of each of these motors and of all other motors connected to the 6600 V. system we have installed surge arresters. We believe this is the best place to dissipate line or switching surges, just where they begin to pile up ahead of the first turns of the motor winding. That these surge arresters have been of value is indicated by the fact that we have found on inspection evidence of arcs at spark gaps in several instances. We have also had one case of break down of motor windings that we have attributed to switching surges and this was on a motor on which we had not, as that time, installed surge arresters at its terminals.

In the 42" Universal Skelp Mill, the main roll drive consists of a 4500 HP., 750 V., D.C. motor with a speed range of 120 to 255 R.P.M. by shunt field regulation and of 0 to 120 by regulation of generator field. Power for this motor is supplied

from a flywheel set consisting of one 3000 HP., 500 R.P.M. slip ring motor direct connected to two 1800 KW., 375 V., D.C. generators, the armatures of which are connected in series and in series with the motor armature. This type of drive was installed to enable very low entering speed of slabs on first passes and high delivery speed, especially on the finishing passes and has proven very satisfactory, both as to tonnage produced and cost of operation and maintenance.

The auxiliary drives throughout the Skelp Mill, as well as in the hot end of the Pipe Mills, consist almost entirely of 230 V., D.C. mill type motors. This type of motor has also been used on all cranes and was chosen because of ruggedness and totally enclosed design which particularly adapts them to the rough usage and dirt that goes with the hot ends of steel mills.

Magnetic control has been installed on all motors of 25 HP. or greater and in many cases on motors of smaller capacity, where occasion warranted. Each motor is protected by an inverse time element circuit breaker with trip free handle and non-closable overload instead of with line switch and fuses, and

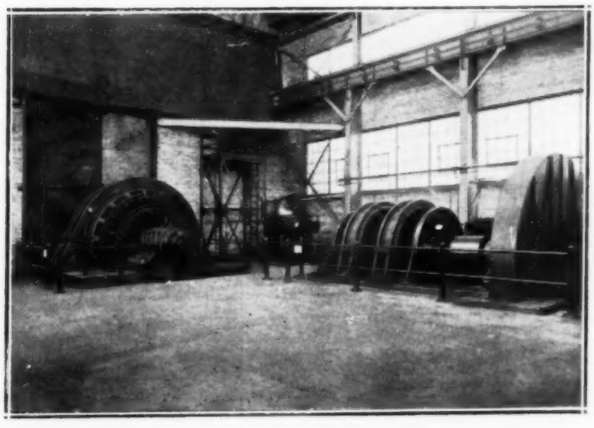


FIG. 5—M-G Set and Main Drive Motor 42" Universal Skelp Mill.

while the original installation was more expensive, we feel that the results obtained in low cost of maintenance and elimination of delays while replacing fuses has justified this extra expense.

In our Pipe Mill unit, the nature of our finishing processes requires adjustable speed motors and these drives consist of standard industrial type motors, in nearly all cases with a speed range of 4 to 1. Most of these motors are under 20 HP. in capacity and are equipped with manually operated drum type controllers with both armature and field points on the control cylinder.

D.C. current for the auxiliary motors in the Pipe Mills is furnished as to the Skelp Mills, from motor generator sets, there being three 1500 KW. sets in the Pipe Mill Sub-Station. One of these, however, is normally held as a spare. The one set at the Skelp Mills and two at Pipe Mill have ample capacity to supply all D.C. current required.

In order to permit the greatest amount of flexibility in the use of these sets, we have a D.C. tie line between Skelp Mills and Pipe Mills and while the circuit breaker in this line is normally open, we can, in case of emergency, transfer enough current from Pipe to Skelp Mills to enable operations.

We have also, a 220 volt, A.C. tie line between Pipe and Skelp Mills with circuit breaker normally open. By use of these two tie lines, it is possible on week-ends or at other times when operations are at a minimum to cut power off either Skelp Mills or Pipe Mill high tension bus, to clean insulators or to do other maintenance work. It was because of

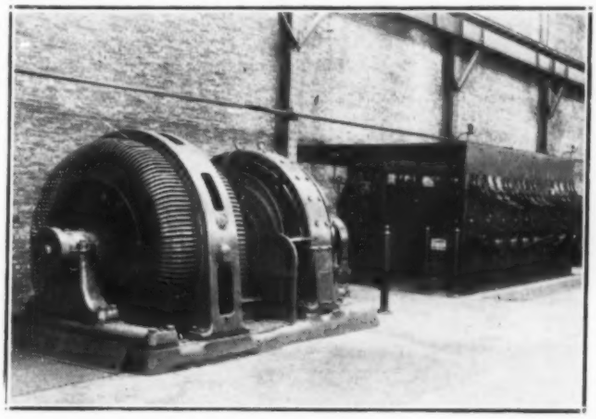


FIG. 6—1500 KW-M-G Set and Low Tension Switchboard, Continuous Skelp Mill Motor Room.

this possibility that we installed single instead of parallel busses in these stations.

In the Pipe Mill Sub-Station we have also three 2175 cu. ft. per minute air compressors each driven by a 400 HP., 6600 V. synchronous motor, three pumps for high pressure water, each driven by 150 HP., 220 V., slip ring motor, six 275 K.V.A. single phase static transformers, 6600 to 220 V. furnishing power for A.C. auxiliaries and lighting, a CO_2 type

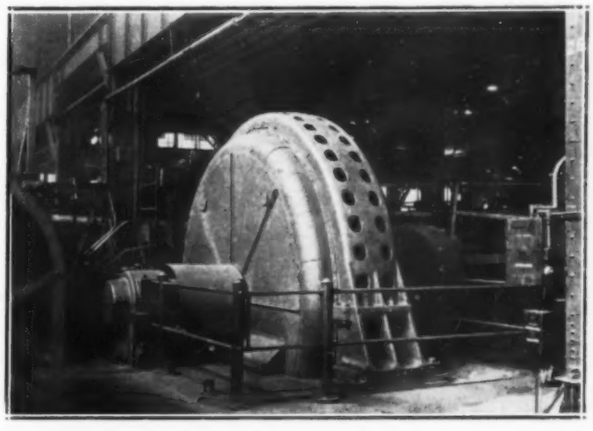


FIG. 7—1500 HP Synchronous Motor No. 1 Seamless Mill.

refrigerating plant supplying cold drinking water to a circulating system throughout the Pipe Mills and a charging set for charging narrow gauge electro-locomotive batteries.

In the Seamless Pipe Mill, the main drives consist of 2500 HP. slip ring motors on Piercing and Expanding drives and a 1500 HP. synchronous motor on Rolling or Plug Mill and 250 HP., D.C. motors on Reeling Machine Drives.

On cranes, we were particularly fortunate in getting an unusual amount of duplication through having purchased the greater number of our cranes at one time, and through the fact that in the Pipe Mills nearly all the cranes are of the same capacity and of the same general style. These cranes, as before stated, are motored with mill type motors and have magnetic reversing controls on bridges, and magnetic dynamic lowering controllers on hoist. No mechanical load brakes have been used on any of these cranes. Manual drum type control is used on all trolleys.

On the last two cranes purchased, the mounting of the crane on spring trucks was tried out. For some years past, the writer has believed that springs on a crane would show quite as beneficial results as on a freight car and the chief engineer of one of the crane building companies was sufficiently in accord to develop such a crane, with the result that we now have two in service. The first one of them was equipped with regular sleeve and MCB bearings and the second with roller bearings throughout the crane, and while neither of them has been in service long enough for us to be able to show in dollars and cents, the savings and benefits to be derived from them, we believe that one ride the length of the runway in either of these cranes and then on the other standard cranes on the same runway will convince most anyone that there is justification for our belief that the saving is there and will show up in time in reduced cost of maintenance of crane, runway and buildings.

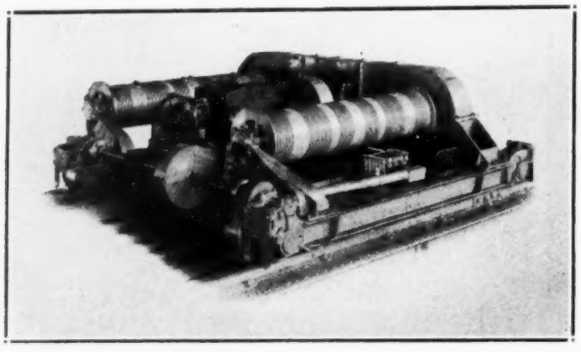


FIG. 8—Roller Bearing Trolley 10 Ton Pipe Handling Crane.

Crane repair platforms have been erected along each crane runway to provide working space for track wheel changes and similar work on every crane in the plant, and one other safety feature in connection with cranes which I have not heard of being used in any other plant is a half-inch steel messenger wire strung the entire length of each runway and bolted to the columns six feet above the crane runway, thus providing a hand hold for anyone who may be compelled to walk a crane runway or over which a safety strap may be thrown when anyone is required to work on the runway. These messenger wires were installed as a result of a suggestion by one of our employees.

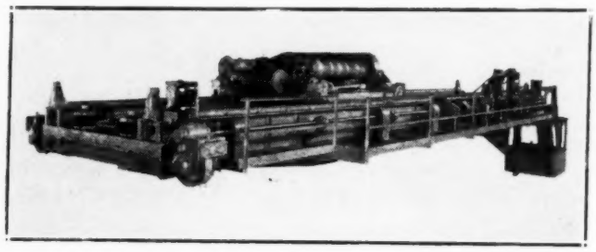


FIG. 9—10 Ton Pipe Handling Crane with Roller Bearings and Spring End Trucks.

Telephone service is furnished throughout the plant through a 100 switch automatic telephone switchboard, on which is also provided a code call that flashes code lights throughout the plant for anyone to whom a code number has been assigned, and a watchman's recording clock from which our night watchman calls in from designated phones and registers the time of his calling and the phone from which he called. We have also a manually operated private exchange connected to Bell system, with phones in the offices of department heads. The system is used only for outside calls and are confined as far as possible to business calls.

40" Reversing Blooming Mill, Wisconsin Steel Co.

By F. A. WILEY*

THE Wisconsin Steel Works of the International Harvester Company, located at South Chicago, Illinois, put into operation in September, 1925, a 40" reversing electrically driven blooming mill. Demands for increased production, lower operating costs and better quality prompted this action. Up to that time the billet production had been produced in an old 35" engine driven blooming mill. Installed along with the 40" blooming mill were new soaking pits, ingot handling equipment, bloom shears and billet storage facilities.

The general arrangement of the entire blooming mill is shown in plan view by Figure No. 1. A more detailed layout of the motor room is shown by the plan and section views of Figure No. 2.

The electrical drive is of considerable interest, in that, the 7000 H.P. reversing motor was the first of such large single armature machines, supplied with power from direct current generators in parallel, to be placed in service. Figure No. 3 is a view of the motor room showing the arrangement of all of the principal machines, which comprise the reversing equipment.

The reversing roll motor (Figure No. 4) is of the single armature, direct current, compound wound, compensated type, rated at 7,000 H.P., continuous 50° C. rise, 700 volt 50/120 R.P.M. The motor was designed to develop a maximum emergency torque

*Elec. Supt., Wisconsin Steel Co., South Chicago, Ill.

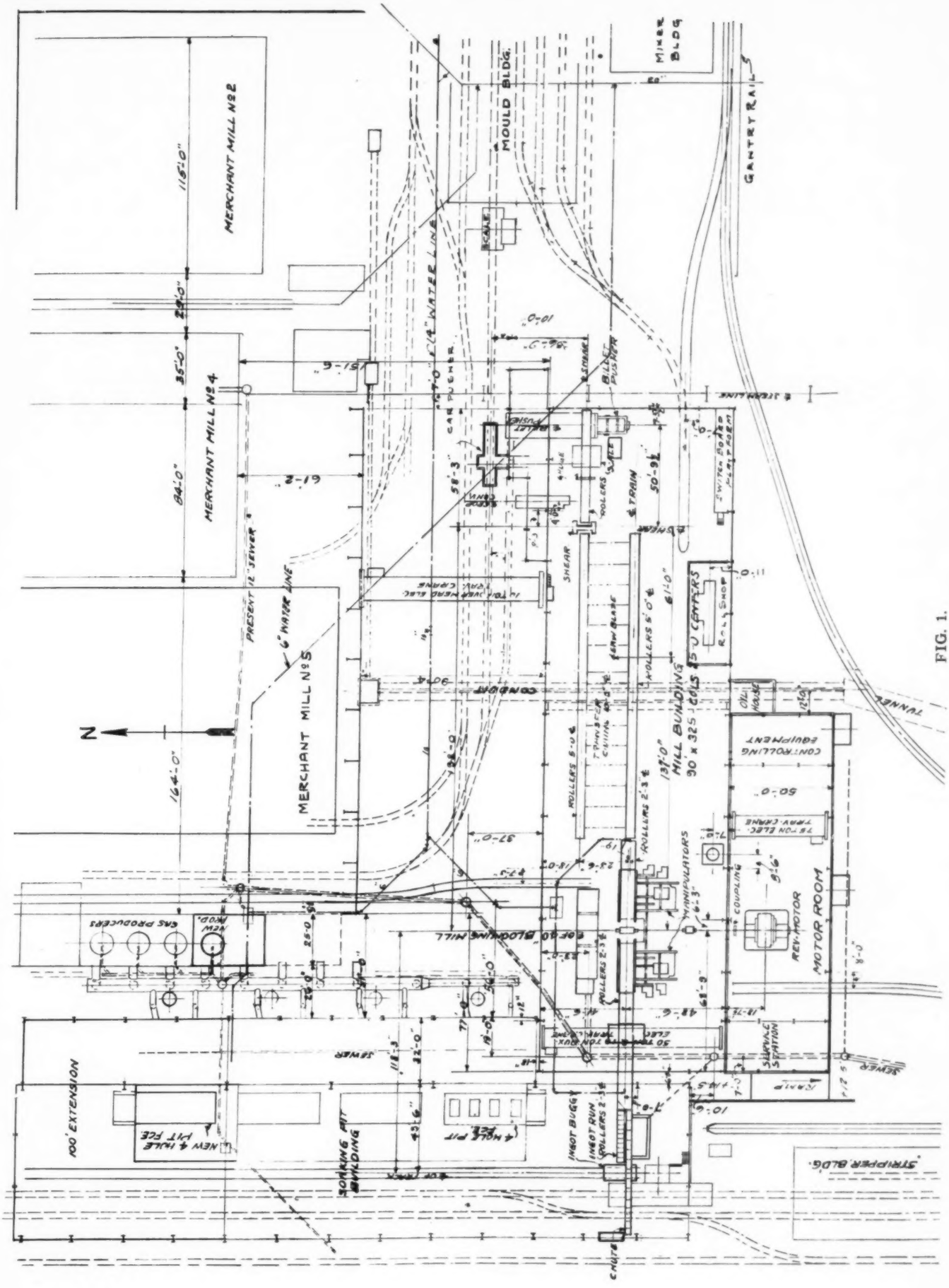

MERCHANT MILL N°2
MERCHANT MILL N°4
MERCHANT MILL N°5
MOULD BLDG.
MIXER BLDG.
GANTRY RAIL
MILL BUILDING
30 x 325 COLS 15'-0 CENTERS
MOTOR ROOM
CONTROLLING EQUIPMENT
REV. MOTOR
COUPLING
STRIPPER BLDG.
100' EXTENSION
BORING PIT BUILDING
INGOT BUGGY
INGOT RUN
SEWER
N

FIG. 1.

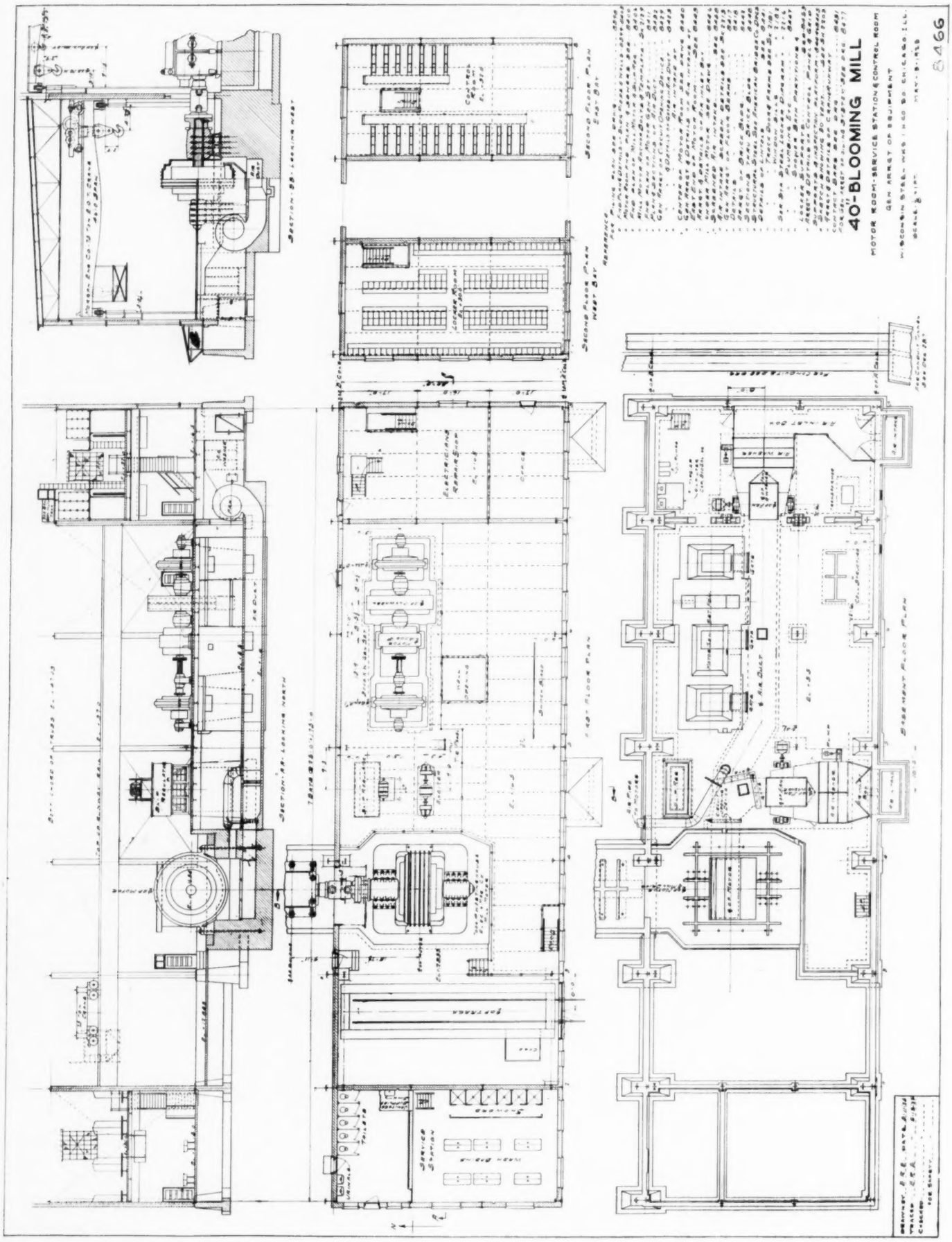

40"-BLOOMING MILL
MOTOR ROOM-SERVICE STATION & CONTROL ROOM
GEN. ARRGT. OF EQUIPMENT
8466

FIG. 2.

of 2,000,000 foot pounds at speeds up to the full field speed of 50 R.P.M. This corresponds to a maximum peak capacity of 19,000 H.P. at 50 R.P.M.

Variable voltage direct current power for the operation of the 7,000 H.P. reversing motor is supplied by a flywheel motor generator set. This set consists of a 4,000 H.P., 20 pole, 353 R.P.M., 3 phase, 60 cycle, 2200 volt, wound rotor induction motor; a 100,000 pound, 14 foot 9 inch diameter cast steel flywheel and two 3,000 kilowatt, 700 volt, compound wound, compensated, direct current generators. The generators are operated permanently in parallel to supply the single armature reversing motor. By the single inter-connection of the generator field windings the load is equally divided between the two generators and there is practically no unbalance of current under any condition of operation. Figure No. 5 is a view of the flywheel set. Excitation for the direct current generators and reversing motor is supplied by a small three-unit induction motor driven exciter set.

Figure No. 6 is a view of the 70 kilowatt, 250 volt, generator unit that provides a constant potential source for the generator and motor main fields and for the operation of the control contacts and relays. A 15 kilowatt variable potential unit provides the compounding excitation for the reversing motor. This series exciter is excited from the main motor armature current, and hence generates a voltage at all times proportional to the main current and this variable potential impressed on a separate motor field winding gives the effect of a series winding.

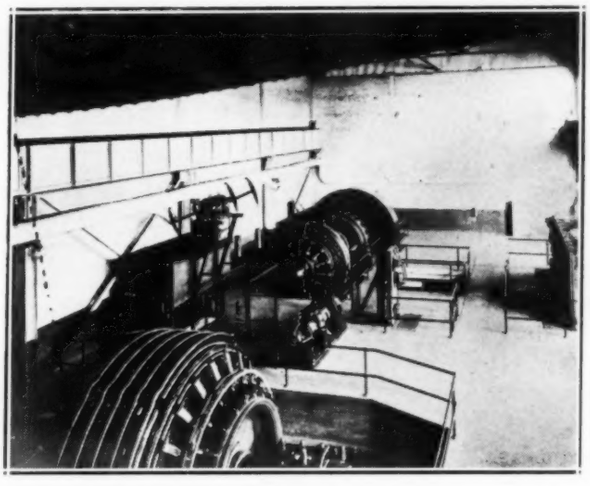


FIG. 3.

The switching and control equipment occupies thirteen, 90 inch high, slate panels (Figure No. 7.) Twelve of these panels are mounted in line at one side of the motor room and the tie circuit breaker panel being mounted apart so as to shorten the heavy direct current bus connections between the flywheel set, series exciter and reversing motor. Solenoid operated oil circuit breakers for the primary control of the induction motor of the flywheel set are mounted in steel cells in the basement. The primary of the auxiliary power transformer is also controlled from these same oil circuit breakers. The individual controllers for the exciter, blower, and air washers pump motors being so arranged that the auxiliary motors which they control can be operated only while the forward circuit breaker is closed.

The auxiliary power transformer is 3 phase, 60 cycle and 200 Kva capacity. The auxiliary voltage is 440 volt and a 300 volt tap is brought out for starting the exciter and blower motors. Magnetic starting of the auxiliaries is used, the control being from control switches on the main panel. The exciter set is also interlocked so that the exciter set cannot be started and the equipment placed in operation until the ventilating equipment is first started. The operation of the reversing motor is controlled by the well developed variable generator voltage and shunt field method. Direction of rotation and speed adjustment up to full field speed of 50 R.P.M. are controlled by reversing and adjusting the strength of the generator field excitation. The direction of the motor field excitation is not changed during the operating, but speed adjustment from the full field speed of 50 R.P.M. to the maximum speed of 120 R.P.M. is obtained by varying the strength of the motor shunt and separately excited series fields.

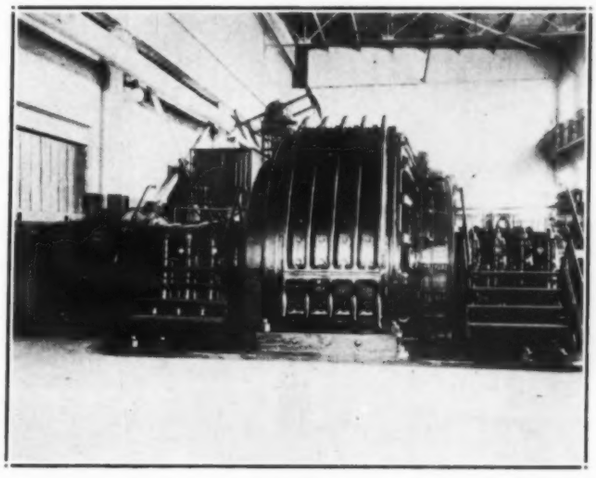


FIG. 4.

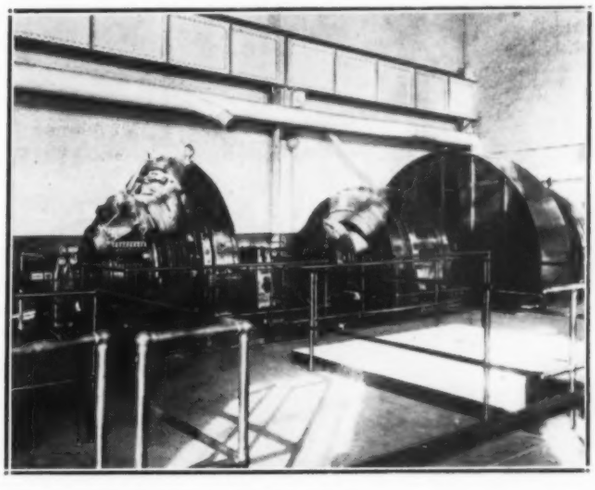


FIG. 5.

The control of the motor and generator field current is by means of magnetic contactors, which in

turn are controlled from a foot operated master switch located in the mill pulpit. The field controller also includes a number of automatic relays which assist in the proper manipulation of the mill, preventing abuse and at the same time permitting the maximum safe rate of acceleration and retardation. In addition to the foot operated master controller, which is used for normal rolling operations, there is provided in the rollers' pulpit a small hand operated "inching" controller which is used in setting up the mill, making roll changes, etc. One point on this controller completes a generator field neutralizing connection, thus reducing the generator residual voltage to zero, stopping the creeping of the motor without the necessity of opening the main circuit breaker. Other point on the "inching" controller

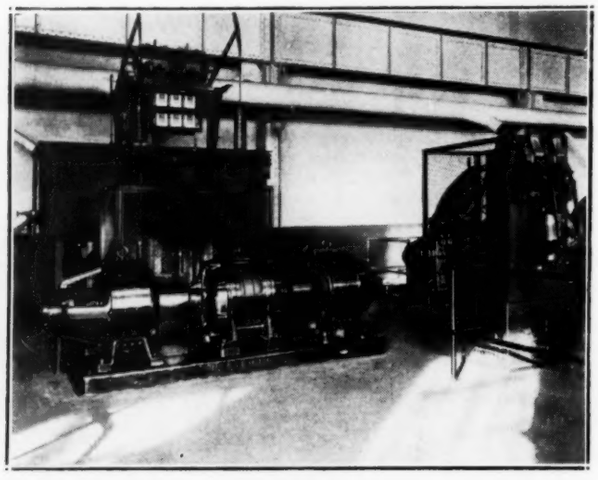


FIG. 6.

weakly excite the generator fields giving a setting up speed considerably lower than the first point on the main controller.

The secondary circuit of the 4000 H.P. induction motor is controlled by standard electrically reset liquid slip regulator. This regulator is entirely automatic in operation, both during starting and in normal operation, closing either the forward or the plugging primary oil circuit breaker, releases the electrode arms and permits the moving electrodes to approach the stationary electrodes. This action is retarded by the action of the torque motor so that the set is smoothly accelerated to full speed with no greater current peaks than occur during rolling.

Opening the primary oil circuit breaker causes a suitable voltage to be impressed on the torque motor which separates the electrodes and latches the electrode arm with all secondary resistance inserted, ready for the next start. Interlocking is such that the arm must be latched open giving maximum secondary resistance in order to close either primary circuit breaker.

Electric heaters are placed in the pits under the reversing motor and flywheel set. Magnetic control is provided for interlocking the heater circuit with the primary oil circuit breaker so that the heaters may be energized only when the equipment is shut down. Keeping the machines warm during idle periods prevents the condensation of moisture following sudden changes in room temperature.

All bearings are of the ring oiling type. Also provision is made for a gravity oiling system, so that all bearings are continually supplied with cool filtered oil. The reversing motor and flywheel bearings are provided with cast-in water cooling coils so that water may be circulated through the bearing shell if necessary. The reversing motor is of the enclosed type and must be artificially ventilated to develop its normal rating. Two duplicate 50,000 C. F. M. air washing and ventilating equipments are situated in the basement and normally supplies air to the reversing motor and flywheel set through underground ducts. The air ducts are so arranged that either ventilating equipment may be used for the reversing motor by the proper setting of the duct gates. It is desirable to use both ventilating equipments to keep the room temperature at desirable value, also when both equipments are in operation a pressure is maintained in the room which practically eliminates all dust.

The mill was laid out and installed to be able to roll a variety of heavy ingots to be further reduced in a smaller mill to be installed later. Under the present operation the greater proportion of the tonnage is a 4" x 4" billet and the heavy equipment is therefore operating under a distinct handicap in regard to the tonnage output and average power consumption. Figure No. 8 is a section of a graphic wattmeter chart taken on the 4000 H.P. induction motor driving the flywheel set, which indicates the

FIG. 7.

average loads drawn from the power system by the operation of this mill. The average peaks are now limited to about 2500 kilowatt by the slip regulator. This setting is quite ample for the schedules now being rolled. When future conditions warrant, regular settings can safely be moved up to a higher value.

The stripping of ingots is done by two 150-ton electrically operated stripper cranes located in a building adjacent to but detached from the mill building. Two 5-ton charging cranes are provided for charging and drawing the ingots from the soaking pits, each crane being provided with a 5-ton auxiliary hoist for repair purposes. To limit the travel of the charging cranes an ingot transfer is provided to deliver the ingot to the first approach table to the mill. The mill is served by a 60-ton

main hoist, with 15-ton auxiliary hoist traveling crane. Coal for the gas producers is unloaded from railroad cars into a pit. After the coal is properly prepared for use in the gas producers it is finally deposited in hopper above the gas producer with a double drum bucket crane.

Located adjacent to and outside of the main building is a billet storage yard which is served by a 15-ton traveling crane. Magnetic control was used on all crane motions having a motor capacity of 15 H.P. and larger. The gas and air valves are electrically operated with full automatic control. The soaking pit covers are also electrically operated, some of which have manual control and some have full automatic time limit control.

mounted on relatively located panels. The top section of each controller has the directional contactors (and dynamic braking switch when used.) The next lower section contains the main power disconnect switch, control circuit switch, two overload relays and a no-voltage protection relay. The next lower section has the accelerating switches and the main contactor. The bottom section has the transfer motor and control switches for connecting the motor to the regular control panel or to the spare panel. For further convenience every contactor and relay of each controller has adjoining identification letters or numbers suggestive of the functions and all those marks agree with relative letters and numerals on the wiring diagrams. For inspection and maintenance

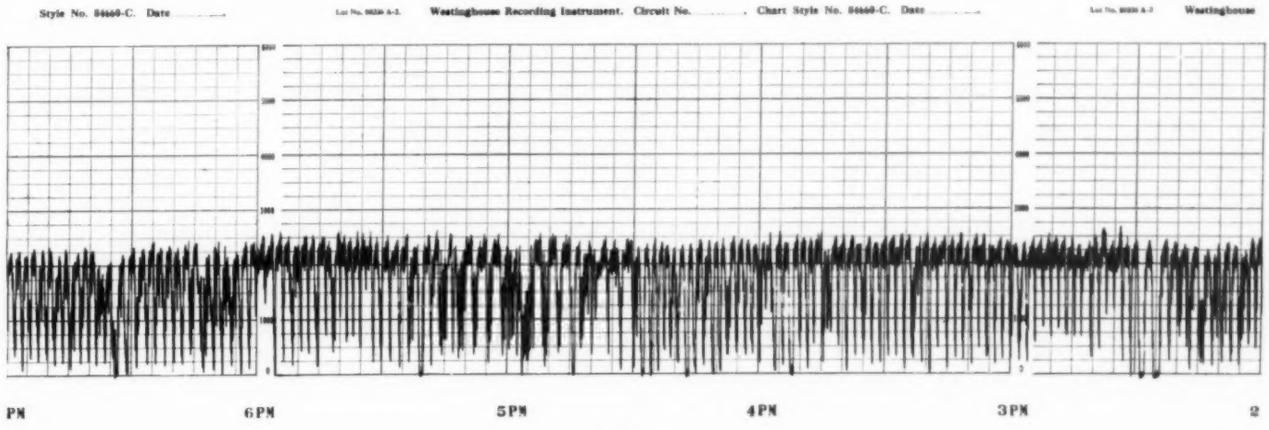


FIG. 8.

The ingot is taken from the soaking pit by the charging crane and deposited on the ingot transfer car which deposits it on the first approach table to the mill. From there it is moved up to the mill and rolled into the proper size bloom and delivered from the mill to a runout table. From there it is transferred to the shear approach table. After shearing the finished billet is delivered to a conveyor which conveys the billet to billet cars outside of the mill. The billet cars are moved up in position by an electrically operated car pusher. The crop ends of the bloom drops down from the shear onto a constant speed crop conveyor, which delivers the crops to suitable pans on the outside of the mill.

The auxiliary motor control panels for all operations up to where the bloom is delivered to the bloom shears, are located on the second floor in the building which houses the main drive equipment. The control panels for all operations from the shears incident to finishing the bloom are located in a suitable room adjacent to the finishing end of the mill. In locating the control equipment in separate rooms they are protected from the ever prevalent mill dust and the grouping of the panels at one location permits very convenient maintenance and use of emergency service panels.

Each of the control panels consist of four slate sections assembled vertically and the panels are arranged to form a continuous switchboard, (Figure No. 9). Stenciled on each panel is the name of the drive it is connected to. This identification is very convenient, because of the remote location and grouping of the control panels. For standardization and convenience relative units of each controller are

work it is only necessary for the inspector to throw the transfer switches on any control panel and then open the power switch and proceed with the work to be done on the panel. After the work is finished the panel can be restored to regular service by resetting the transfer switches. All this is accomplished with minimum delay on the mill. The use of the spare panel as described above permits regular inspection and maintenance work to be accomplished at any time.

All resistor boxes have the same overall and mounting dimensions for inter-changeability and handling convenience. Only four different boxes are used for making up the resistors for motors in sizes from 20 to 150 H.P. The resistor boxes are mounted in racks directly above their relative panel (Figure No. 10).

The master switches for the screw down, reversing tables, manipulator lifts and side guards are located in the rollers' pulpit on the approach side of the mill. The master switches for the runout and transfer tables on the delivery side of the mill are located in a pulpit just ahead of the bloom shears.

Two men control the rolling process. The roller is seated on an elevated platform directly back of the manipulator man and controls the main motor with a foot operated master switch, the screw down master switch is at his left hand and the master switches for the front and rear tables are at his right hand. The master switches for the tables are mechanically coupled together for simultaneous operation, but can be quickly uncoupled if desired. The table masters have two running points each side of the "off" position. On the forward motion the first

point of control runs the front table toward the mill, and the second point on the control runs the front table toward the mill and the rear table away from the mill. On the reverse side of the master the operation is reversed. When the table masters are operated between the first points the ingot is kept close to the rolls, because only the table on the entering side is run, therefore the ingot falls on a "dead" table on the delivery side and consequently is not carried away from the rolls. The manipulator lifts and side guard masters are operated by the second man who is on a lower level, but directly in front of the roller. The men are located this way so they both have an unobstructed view of each pass at the rolls. The manipulator lifts are equipped with limit switches and solenoid brakes. The lifts make a complete cycle and stop automatically when the master is moved to the running position. The function of the limit switch is to stop the lift in the same position each time and also eliminate one motion of the master.

The screw down has two series motors which operate in series when lowering the rolls. The armatures are in multiple and the field in series when raising the rolls. These connections provide for a quick opening of the rolls with a single control combination. The screw down motors are equipped with series wound solenoid brakes.

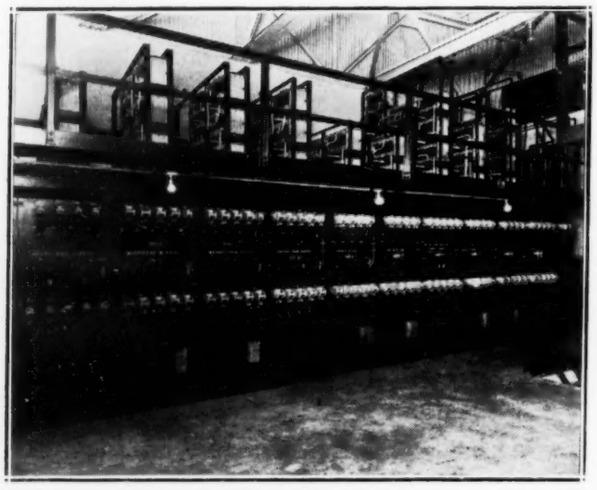


FIG. 9.

The front and rear tables are each driven by two 100 H.P. series wound motors, connected permanently in series.

Manipulators are provided on both sides of the rolls. The manipulator lifts are driven by one 100 H.P. compound wound motor through reduction gears, solenoid brakes are used to insure a positive stop.

Each side guard on both sides of the rolls are mechanically connected together and driven by two compound wound motors connected permanently in series. The larger guard is driven by two 100 H.P. motors and the small guard is driven by two 100 H.P. motors. Provision is also made whereby the mechanical connection may be disconnected and each side guard operated independently with one motor when desired.

On the delivery side of the mill a runout table conveys the finished billet to a position parallel with a rope transfer table. The transfer table is driven by two 70 H.P. compound wound motors connected in multiple. This movement is controlled by geared type limit switches, which limits the maximum travel in both directions, solenoid brakes are also used on these motors. All other drives and control incident to the finished billet are of standard design.

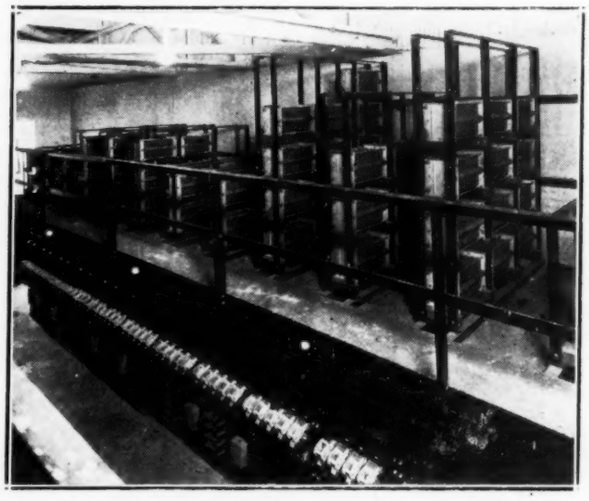


FIG. 10.

Artificial ventilation is provided for the auxiliary motors driving the front and rear tables at the rolls, screw down and manipulators which is obtained from one of the air washer equipments for the main drive.

The main drive equipment and the auxiliary motors were furnished by the Westinghouse Electric & Manufacturing Company. The control and magnetic brakes for the mill auxiliaries were furnished by the Cutler-Hammer Manufacturing Company. The control equipment for the soaking pit doors was furnished by the General Electric Company and all crane control was furnished by The Electric Controller & Manufacturing Company.

The JUNE ISSUE of Iron and Steel Engineer will contain advance copies of all papers to be presented before the Annual Convention and Iron & Steel Exposition of the A. I. & S. E. E.

In addition, lists of exhibitors, points and items of interest and other valuable information will be included.

HAVE YOU ARRANGED TO PRESENT A MESSAGE TO THE STEEL MILL ENGINEERS THROUGH THIS ISSUE? Forms close May 10th.

*Accident Prevention, Joliet Works, Illinois Steel Co.**

By JOHN EIB†

I AM indeed happy to be with you tonight not alone for the opportunity to meet and mingle with you but chiefly for this opportunity to pay my tribute to your Organization which has done so much to further Human Welfare in the Iron and Steel Industry.

In fact we might well call this meeting a pioneer meeting; insofar as Accident Prevention is concerned.

As you know, it is my privilege to represent the Joliet Works of the Illinois Steel Company, the Birthplace of Industrial Accident Prevention and where it came into being over 35 years ago. Needless to say, Joliet Works is proud of this distinction as well as the contributions it has made to this cause since that date.

Likewise your Association has a right to be proud of its connection with this great work, for it was from your original Safety Committee that the great Organization—The National Safety Council was conceived and which organization today renders a service in all branches of Safety which reaches millions of people each week. All of the agencies combined have accomplished much to eliminate preventable accidents. So I repeat, that each member of the Association of Iron and Steel Electrical Engineers may justly feel proud of the human service which your Organization has rendered to mankind and I am indeed happy to have this opportunity to extend to it my sincerest tribute. Your Organization has served and is continuing to serve not only through its Safety Committees but through its experience and engineering ability in designing better and safer equipment. These contributions have been so helpful and numerous that to attempt to enumerate them would require an entire program. Suffice is to say, that the benefits have been most outstanding and further significant of the high type of service rendered by your Association

Thirty-five years have passed since Accident Prevention started at Joliet Works. Thirty-five years may be considered as a very long time or a short time, depending upon either viewpoint or the subject to be reckoned. For some people it may be considered as a lifetime and for others just a starting period. In reckoning the World's History, 35 years, of course, is a very small period. While my own particular recollection is extremely hazy very much more than this number of years, due entirely to conditions over which I had no control,I can recall nothing in History which might wish me to have lived in any other previous period. Think of the comforts, luxuries and opportunities to live and learn and serve, which are present today. In this age in every hamlet and city of this wonderful country of ours, there is an opportunity for every person to be of service to his fellowman and his community. To my mind, one of the greatest opportunities for service is in the prevention of unnecessary accidents and the attendant pain, suffering and privation which so often accompanies such occurrences and I am indeed happy that it has been my privilege to have helped in this service. All of the 35 years since Accident Prevention was inaugurated at Joliet Works have not been rosy ones. Many of them were filled with pretty rough paths. It was not an easy thing to change the habits of men and officials from the reckless, rough and tumble ways to safer methods.

The Safety Department at Joliet Works was formed in 1892 with the late Captain Smith in charge. In 1893 ht was definitely titled Safety Inspector. This was years before any other company gave this work any consideration whatsoever. Joliet Works, in addition to enjoying the distinction and honor of having the first Safety Inspector in this country, was also the recipient of what is conceded to be the first Safety Order ever issued as such. This consisted of a definite order issued in 1893 from our Executive offices for the regular inspection of all engine fly wheels, after an explosion had occurred. This order was, doubtless, the basis for all present safety mechanical inspection.

Following Captain Smith's appointment other men were appointed at the different works so that all of the plants of the Illinois Steel Company were definitely started in the Accident Prevention Field in 1893. However, the appointment of these men as Safety Inspectors back in those early days did not by any means settle the problem nor did it mean as much as it seems on the surface because it was entirely a "One Man Job."

There was no co-operation to speak of from either side of the house. The Executives felt that while too many accidents and deaths were occurring, their own job was to make steel and that was the main issue. While this attitude seems strange to us today it must be remembered that at this early date the development of the iron and steel industry was still in the pioneer stage and the pioneers in it struggled against such great obstacles and were so occupied in the development of processes that they could give only slight consideration to the human side of steel making. Accidents were treated as a necessary and unpreventable evil—one of the hazards of the industry. Besides the indifference of the officials, in many instances indifference and direct opposition came from the workers many of whom believed that their jobs called for taking chances and that recklessness and daring was the proper way to show efficiency, and that the newfangled ideas about **caution, care, safety rules** and **inspection** was something new the company was trying to slip over on them. So this was the condition which existed in the early days. The processes of manufacture were steadily developing and so was the casualty list, until it reached such proportions that it was realized by all concerned that the subject of conserving the greatest of all resources

*Presented before Chicago Section, A.I. & S.E.E., February 21, 1928.

†Safety Director, Joliet Works, Illinois Steel Company,

ILLINOIS STEEL COMPANY

JOLIET WORKS

DEPARTMENT OF SAFETY AND LABOR
PLANT ORGANIZATION

FOR

SAFETY SANITATION WELFARE

PLANT CENTRAL COMMITTEE

DEPARTMENT OF SAFETY AND LABOR

DEPARTMENT ORGANIZATIONS

EDUCATION

SAFETY RULE BOOKS	PLANT PREACHER	SAFETY BUTTONS	INSTRUCTION CARDS	FOREMEN'S SAFETY MEETINGS	WORKMEN'S SAFETY MEETINGS	BULLETIN BOARDS	MOVING PICTURES	THE MIXER	DISCIPLINE

ORGANIZATION

DEPARTMENT PERMANENT COMMITTEES	WORKMEN'S COMMITTEES	PLANT SAFETY INSPECTOR	GANG SAFETY MEN	CHAIN AND CABLE COMMITTEES	LIGHT COMMITTEES	ROOF INSPECTION	ELECTRICAL INSPECTION	ELECTRICAL CRANE INSPECTION	BOILER INSPECTION

WELFARE

LOCKER AND REST ROOMS	WASH AND SHOWER ROOMS	PLANT RESTAURANT	STEEL WORKS CLUB	SANITARY DRINKING FOUNTAINS	EMERGENCY DISPENSARY	GOOD FELLOW CLUB	VISITING NURSE	CHILD WELFARE STATION	STOCK SUBSCRIPTION	PENSION PLAN

—HUMAN LIVES—demanded not only study but action.

The first real beginning of organized Accident Prevention in the country was made in 1906 by the U. S. Steel Corporation. At this time a meeting of all of the casualty managers of the Subsidiary Companies was called in New York City for the purpose of outlining a definite plan for use in all plants of the Corporation. This was followed by the formation of the Committee of Safety of the Corporation in 1908. Immediately after similar central committees of Safety were formed in all Subsidiary companies, with Safety Engineers, Inspectors and Committees at all plants.

It is impossible for me to attempt to outline all of the activities in our Accident Prevention Campaign in the short space of time allotted to me but those indicated on the chart, Fig. 1, are a number of the chief items and have been the means of very materially assisting in accomplishing exceptionally worth while results at our plant.

Our Campaign was originally divided into three efforts—ORGANIZATION—SAFE GUARDING—and EDUCATION.

ORGANIZATION was the first step as experience had conclusively proven that safe guarding and educational work was not a "One Man Job" and that satisfactory results could only be secured through the highest measure of co-operation between the employer and his employes, and this only by means of organization.

SAFE GUARDING of dangerous places and machines was the next step, which was followed by Education.

EDUCATION in the sense it is referred to here means the training of employes to think about their work. While there is no questioning that safe guarding machinery is one of the essential features in Accident Prevention, statistics do not show, however, that the failure to guard dangerous places is the greatest source of accidents. If this essential feature is overlooked there is not the slightest doubt that reckless habits will follow. It is the result of our studies that the greatest efficiency in our Accident Prevention Campaign is obtained through education. The amount of care exercised by workmen largely enters into the number of accidents occurring at any plant and the only way this number can be materially reduced is by the inculcation of habits of caution. It is not sufficient to SAY, however, that the men must be careful. The burden of instilling rests upon the management of a plant or a department.

The first step in an Accident Prevention Campaign is the development of an attitude, or if you will, a conscience. Needless to say that conscience must first be manifested by the Executives and from there reflected on down to include everyone in the organization, with special reference and attention to the Foreman in reaching the men. Any Accident Prevention Campaign in order to meet with success must be planned to assist the foremen.

The foremen are the ones who have an opportunity to learn each man and to become familiar with them and their ways **and that familiarity, if rightly used, is a wonderful thing. It will breed sincerity and right-thinking will follow.**

The importance of right-thinking is its effect upon right-doing.

Right-thinking means that which constructs, strengthens and ennobles.

All of this leads to understanding, and understanding, in the development of a Safety Conscience, is the greatest problem of the day; understanding on the part of the foreman as a leader and on the part of all others as right followers.

Safety is the one thing and probably the only thing upon which everyone can agree and it is a thing in which everybody should be interested; every man, woman and child, every church, every school and every organization of whatever kind. We may disagree as to religion and to politics. We may disagree as to who has the best baseball or football or hockey team. We may even disagree as to the make of a car and countless other things; but there is one outstanding thing upon which everyone can agree. **We will all agree that it hurts to get hurt,** and the point, therefore, is what we can do about it.

We will now turn to the chart on the wall which outlines a number of the items which we have carried out to help in the elimination of unnecessary and preventable accidents.

SAFETY RULE BOOKS

Long ago we found that the place to obtain that first step in attitude was at the Employment Bureau. Every man who enters the employ of the Company must first pass through the Employment Bureau. It is here that he obtains his first contact with the Company and it is here that his first attitude is formed, either favorable or unfavorable. Needless to say, he is entitled to courteous treatment.

It is here that we also endeavor to make the first Safety contact and to help form a Safety attitude. A Safety Rule Book printed in his own language is given to each man (we have them printed in ten (10) different languages) and he is told the purpose of the book and that he is expected to read and learn the general rules and also the rules for his own department and be prepared to pass an oral examination on his knowledge of the rules.

PLANT PREACHER

We have in our department a man who is versed in the several foreign tongues whose duty it is to visit every new man at his work and in conjunction with the foreman explain to the man the dangers and hazards of his place of work, and also what the Company desires from a Safety standpoint. We have chosen to call this man the PLANT PREACHER. He spends all of his time talking to new men and holding Safety Meetings with other workmen, driving home the Gospel of Safety First.

I was talking to a good gentleman about this point not along since and he said, "Well you have to do that, you have so many foreigners that you must have an awful job with them." Let me tell you that most of our accidents do not occur to the so-called foreigner, but to the Americans. The foreigner is often slower to grasp but once you get him to understand, he is with you; but we Americans—just naturally love to take chances.

SAFETY BUTTONS

As stated before we not only ask a man to read his Safety Rule Book but insist upon it and peri-

odically hold oral examinations with all men on their knowledge of the rules in the book. For efficiency of 90 per cent or better in this test a Safety Button, or Badge of Distinction, is awarded. If a man fails he is given another trial with sufficient help to make each rule clear. There is always someone to help explain the rules—sometimes the foreman or fellow-worker—sometimes the children at home and sometimes the Plant Preacher. If a man continues to fail it is usually because he either won't or doesn't want to try. It is a pretty fair conclusion that such a person is not a safe man and as such we don't want him in our organization. There is no hardship connected to this examination in fact there is usually competition to see who is first to win a button. We have examined men who could neither read nor write and yet gave a clear understanding answer to ?? rules, and we usually ask only 10 or 12.

INSTRUCTION CARD

After a new man is hired an Instruction Card is sent to his Foreman from the Employment Bureau. This is a printed form and the foreman must signify that he has instructed the man and sign his name to that effect. The man must also sign the card that he has been instructed by his Foreman. When necessary to use an Interpreter there is a space for him to sign also. These cards are then returned to the Employment Bureau and kept as a permanent record.

The three I's stand for three of the most important features in our Accident Prevention Campaign— INSPECTION — INVESTIGATION — and INSTRUCTION.

Inspection for dangerous places and practices.

Investigation of all accidents to find means for the prevention of similar ones, and

Safety Instruction of all workmen.

I say the Instruction of all workmen, you will note, as our experience has been that the majority of serious accidents occur to men who have been on the job for one year and over, so it is not usually the new man but the experienced one who gets hurt.

The old saying that familiarity breeds contempt finds a very prominent place in accidents as well as elsewhere.

FOREMEN'S SAFETY MEETINGS

For a number of years we have followed the practice of having Safety meetings with all foremen during each month. At these meetings the record for the previous month is gone over in detail and each accident wherein a lesson may be gained is carefully considered with means for prevention of a similar one decided upon. These meetings offer an opportunity to get together and talk over safety matters and problems and also serve to keep the foremen posted on Safety activities, and provide an opportunity to exchange confidences.

WORKMEN'S SAFETY MEETINGS

After the Foremen's meetings are held each Foreman then holds similar meetings with his men. A sufficient number of these meetings are held by each Foreman so that all men have an opportunity to attend at least one meeting each month. This provides an additional means of directly reaching and appealing to the man for his co-operation and support in Accident Prevention.

BULLETIN BOARDS

The next division is that of Bulletin Boards. Throughout the plant we have placed a number of Safety Bulletin Boards. In these boards we place material such as stories of accidents, near accidents, newspaper clippings of accidents, roughly drawn chalk cartoons and pert sayings arranged in an attractive manner to keep men interested in Safety. These are illuminated so that the message is flashed twenty-four hours per day, and the material is changed twice each week in order to keep up the interest.

MOVING PICTURES

Another means of education which we have employed to some extent is that of moving pictures. Operating conditions and lack of satisfactory space has prevented as complete a follow-up as our other activities. The results obtained thus far have been very beneficial. The idea of moving pictures is interesting and appealing to all men and overyone can grasp the Safety lesson regardless of the language he may happen to speak.

PLANT PUBLICATION—"THE MIXER"

For a number of years we have been issuing a monthly plant magazine called "The Mixer." We feel that by means of editorials, cartoons, patriotic poems and sayings, stories of accidents, illustrations of safe manner of working, illustrations of sanitary installations, welfare activities and items of plant news, we have a direct means of promoting a feeling of good will, a vehicle to convey to the workmen the ideals and spirit of the organization and a means of boosting Accident Prevention.

DISCIPLINE

The next division is that of discipline. This is a matter which we require each Foreman to keep strict accounting of. It is impossible to maintain an organization of 3,000 men without discipline. This item plays a mighty important part in our Safety Campaign. It may seem rather unusual to you gentlemen for me to talk about discipline in relation to grown-up men and especially in regards to Safety but that is exactly what we are obliged to do. We often find it necessary to refuse to let a man work in order to impress upon him the importance of protecting his own life and that of his fellow-workers. We don't want that object lesson to be an accident and it is our practice to first have a friendly visit with the man and point out the possible seriousness of his action. I am happy to state that in the vast majority of instances in our experience this visit and a reprimand have the desired effect of making Safety Boosters of the men and their good will and co-operation thus obtained. Ossacionally it has been necessary to send men home for a few days to think the matter over. The loss of time and the fact that he was sent home for being unsafe generally have the result of making a Safety Booster.

ORGANIZATION

The next section shows the method of organization.

DEPARTMENT COMMITTEES

The first step was that of organizing a Permanent Safety Committee in each department. This Com-

mittee was composed of the Master Mechanic and two other Foremen and next to the Department Superintendent they are in executive charge of the Safety Campaign in each department.

For the past eight years we have worked a plan of enlarging the Committee to include a number of leading workmen in the various sub-divisions of a department so that a mixed committee of foremen and workmen was obtained. This plan has proven very satisfactory as a larger number feel a responsibility in the prevention of accidents. These workmen are changed from time to time so that more men have an opportunity to serve.

WORKMEN'S COMMITTEES

The next step was the formation of the Workmen's Committees for the Inspection not only of their own departments but of other departments as well. A regular schedule is made up each month so that each department is visited monthly by a Committee from some other department. It was found by the interchange of inspection that oft times a stranger would notice unsafe conditions which should be corrected while a man in the department had become so familiar with the condition that he accepted it as being safe. It is usually easier to see the other fellow's fault than it is your own. The result was that the department did a lot of careful housecleaning so that the visitors could not find anything which, of course, increased the efficiency of both committees.

PLANT SAFETY INSPECTOR

We have in our department a Plant Safety Inspector. This man spends all his time in the plant inspecting for needed safeguards and that present safeguards are maintained and used, for unsafe practices and unsanitary conditions, investigating accidents and suggesting means of prevention for similar occurrences.

DEPARTMENT SAFETY MEN

The next division is that of gang or department Safety men. For a number of years we have followed the practice of having each foreman appoint someone of his men to act as a Safety overseer. In addition to his regular work, this man also is on the alert for dangerous conditions and practices and reports the same to his Foreman. The man selected to fill this position is given a large Safety badge with the wording "Department Safety Man" on it. As this man is from the ranks, the other men in the gang ofttimes feel more like reporting a condition to him than direct to the Foreman.

CHAIN & CABLE INSPECTION COMMITTEE

The next division is that of Chain and Cable Inspection Committee. This Committee is composed of three riggers who are familiar with this work and their duties require that they inspect each chain and cable on the plant once each month.

LIGHT INSPECTION COMMITTEE

The next section is that of the Light Inspection Committee. This Committee is composed of one man from the Engineering Department, one from the Electrical Department and one from the Safety Department. It is their duty to pass on the question of plant lighting and to make a periodical inspection of all departments and an investigation of all requests for additional lighting. Oftentimes it is not the question of installing additional lights, but the re-arrangement of lights already existing. Illumination should be an aid to the sight instead of a hindrance or a strain.

ROOF INSPECTION

The next section is that of Roof Inspection. This Committee makes periodical inspection of all roofs for the purpose of replacing any defects and making recommendations for their correction.

ELECTRICAL INSPECTION

The next section is that of Electrical Inspection. This Committee is composed entirely of men from the Electrical Department and by virtue of their occupation they have occasion to go to all departments with the result that this Committee serves a two-fold purpose, not only the inspection of electrical equipment but other equipment as well.

OVERHEAD ELECTRIC CRANE INSPECTION

We have a man whose duty it is to inspect the mechanical condition of all overhead electric cranes. This man spends his entire time so that each crane has an inspection each day.

BOILER INSPECTION

In addition to outside inspectors we have a man who spends all of his time inspecting boilers.

WELFARE

Locker and Rest Rooms

It is the plan to furnish a steel locker for every man and also to provide rest rooms adjacent to working places where a man has a safe and comfortable place to spend his rest periods. Wash and shower rooms are being installed as fast as possible and it is the plan to combine the locker and rest rooms with the wash and shower rooms.

PLANT RESTAURANT

You are perhaps somewhat familiar with the Restaurant we have at our plants which has been in operation since January 1, 1912, and was one of the first industrial restaurants to be established in the country and the first one in the Steel Corporation. This Restaurant is operated entirely for the benefit of the men and without profit and provides a place where a man may obtain a well-balanced meal at a reasonable price.

STEEL WORKS CLUB

The Steel Works Club is the name of the building provided by the Company where social and recreational activities for employes of the Corporation are held. A large auditorium offers an opportunity for dramatic expression and moving pictures and also dances. The regular recreational activities such as handball, tennis, swimming, bowling, baseball, etc., are also provided. A large billiard room is also at the disposal of members. Any employes of the Corporation in our city may become a member at the Club for the small sum of $2.00 per year which does not, of course, pay for the cost but the balance is made up by the Company. The new and outstanding feature of the Club was introduced last year in leasing a wooded spot on the banks of a small stream and the installing of suitable buildings and equipment to care for under-privileged children.

Funds to operate this camp during the school vacation are provided through a Minstrel Show.

SANITARY DRINKING FOUNTAINS

The next item is that of Sanitary Drinking Fountains. It is very important to acquire and maintain a pure water supply. Fountains are located convenient to where men work and are so constructed that a person must drink from a stream or a jet and not from an overflowing bowl.

EMENGENCY DISPENSARY

The next item is that of Emergency Dispensary. In addition to treating such cases of injury that occur in the course of employment the maintenance of this dispensary has been the means of pointing out illness and physical defects to employes as well as furnishing advice in case of illness and is a general means of promoting education in matters of **health, hygiene** and **sanitation.**

GOOD FELLOW CLUB

The next item is that of the Good Fellow Club. This organization is one that is promoted, financed and managed entirely by the employes and for the employes. Any employe who wishes to become a voting member contributes the sum of twenty-five cents per month.

Its purpose is to relieve distress and suffering to any employe or any member of his immediate family. This relief may consist of the necessities of life or Hospital or Sanitarium treatment or medical attention or appliances.

It is most distinctly not a charitable organization and no specified benefits are guaranteed, but any relief which is given is tendered with the thought that when a man is unable to work through illness he is being remembered with some help and good cheer from the boys at the mill.

Each department elects a member to the Board of Directors and this Board is in charge of the administration of the Club.

The Club not only gives financial aid, but helps in many other ways. Through its efforts the payment of insurance policies have been hurried up, garnishments released and credit extended when the member was in need.

Loans without interest have been made which are repaid in small sums monthly whenever the recipient is able to do so.

In all cases of aid or donations the name of the person helped is not made public.

VISITING NURSE

The Good Fellow Club also employes a Visiting Nurse who makes periodical calls at the homes of employes for the purpose of treating the sick and instructing in all matters pertaining to health, hygiene and sanitation. The service is not confined strictly to nursing. The object of this service is to improve the general health and increase the happiness of the employes and their families.

One of the principal duties of the Nurse is to give instructions in those things which will enable the employes to better their conditions materially, physically and mentally. Her services are free, but they are not forced. She is not permitted to visit the homes of employes upon any occasions unless requested to do so by a member of the family.

CHILD WELFARE STATION

One of her important duties is that of assisting in conducting the Child Welfare Station which is held under the auspices of the Public Health Council. This Welfare Station has been very well attended and the attendance for last year was 737.

STOCK SUBSCRIPTION

The next is that of Stock Subscription Plan. In January of each year under a plan inaugurated in 1903, shares of stock of the Corporation are offered to employes upon easy and especially favorable terms, which involves benefits beyond those to ordinary stockholders. The price of the stock is the prevailing market or usually a little lower and the payments are such that a minimum may be $2.00 per share per month and the maximum is 25 per cent of the monthly earnings. A premium averaging $5.00 per year for five years is paid on each share of stock purchased by employes under this plan. On December 31, 1925, 47,647 were stockholders under this plan. Their aggregate holdings amounted to more than 665,801 shares of stock.

PENSIONS

The next item is that of Pensions. The U. S. Steel Corporation and Carnegie Pension Fund was established in the year of 1911 by the joint action of the Corporation and Mr. Andrew Carnegie. The principal features of the plan are the provisions for the retirement after 25 years of service. The minimum is $12.00 per month and the maximum is $100.00 per month. The report for January 1, 1927, shows over 6,200 persons have received the benefits of this plan and that up to that date a total of $15,833,725.75 has been expended in pensions since 1901.

This briefly is an outline of the number of the chief items in the Accident Prevention Campaign at Joliet Works which have been the means of producing most gratifying results and wonderful contributions to the great humanitarian cause of saving human lives and limbs. Each year since the inauguration of our Campaign many years ago has seen a marked progress over the preceding year with the past three years the most outstanding in our achievements.

During the calendar years of 1925 and 1926 each department on our plant has made a record of at least 365 consecutive days without a lost time accident and some departments even a greater number and all departments with but two exceptions have made a calendar year during the period mentioned without a lost time case. The year of 1924 was the most outstanding up to that time when there were but seven cases during the entire year where it was necessary for a man to be away from work for more than 7 days on account of an accident and during the year was included three long No Lost Time periods of 95 days with an average of 3,891 men employed per day, 61 days with an average of 2,758 men employed per day and 89 days with an average of 2,788 men employed per day. The year of 1925 not only saw the remarkable record of the previous year equaled but exceeded it for during this year a record of 116 consecutive days with an average of 3,270 men employed per day and with 2,760,141 hours worked without a lost time case, was made. The year of 1926 followed with another remarkable contribution with a record of 109

consecutive days with an average of 2,841 men employed per day and with a total of 2,291,981 hours worked without a lost time case. During this year also there were five of the calendar months without a lost time case.

The year of 1927 crowned all other previous efforts not only in the establishing of the extraordinary record of 256 days with an average of 2,496 men and with 5,028,640 hours worked without a lost time case. In addition to this remarkable record there were nine of the calendar months without a lost time case and with but four lost time cases for the entire year and only three of these where the time lost was more than seven days' duration.

From 1912 to 1927, inclusive, a reduction of 98.7 per cent in no lost time cases and a reduction of 97.3 per cent in the over seven day cases has been made.

In closing I wish to read the records of accomplishments of the individual departments in tribute to their exceptional showing.

DEPARTMENT ACCIDENT PREVENTION RECORDS

Joliet Works—Year of 1927

As of December 31st, 1927, Inclusive

Blast Furnaces. The Accident Prevention Record for this department shows a total of 624 days without either a lost time or over seven-day case.

Converter. The Accident Prevention Record for this department shows a total of 776 days without either a lost time or over seven-day case.

Narrow Gauge. The Accident Prevention Record for this department shows a total of 1,845 days without a lost time case and a total of 1,911 days without an over seven-day case.

Billet Mill. The Accident Prevention Record for this department shows a total of 1,158 days without either a lost time or over seven-day case.

Splice Mills. The Accident Prevention Record for this department shows a total of 1,552 days without a lost time case and 1,577 days without an over seven-day case.

Rod Mills. The Accident Prevention Record for this department shows a total of 264 days without a lost time case and 387 days without an over seven-day case with a previous record of 420 days without either a lost time or seven-day case and with a record preceding that one of 314 days without either a lost time or over seven-day case.

Merchant Mill. The Accident Prevention Record for this department shows a total of 561 days without either a lost time or over seven-day case.

Spike Factory. The Accident Prevention Record for this department shows a total of 551 days without a lost time case and 1,709 days without an over seven-day case.

Bolt and Nut. The Accident Prevention Record for this department shows a total of 1,527 days without a lost time case and 2,816 days without an over seven-day case.

Cooper Shop. The Accident Prevention Record for this department shows a total of 1,321 days without a lost time case and 3,885 days without an over seven-day case.

Coke Plant. The Accident Prevention Record for this department shows a total of 846 days without either a lost time or over seven-day case.

Machine Shop. The Accident Prevention Record for this department shows a total of 387 days without either a lost time or over seven-day case.

Pipe Shop. The Accident Prevention Record for this department shows a total of 1,144 days without a lost time case and 4,672 days without an over seven-day case.

Pattern Shop. The Accident Prevention Record for this department shows a total of 5,150 days without a lost time or over seven-day case.

Carpenter Shop. The Accident Prevention Record for this department shows a total of 2,223 days without a lost time case and 2,993 days without an over seven-day case.

Boiler Shop. The Accident Prevention Record for this department shows a total of 1,135 days without a lost time case and 2,314 days without an over seven-day case.

Blacksmith Shop. The Accident Prevention Record for this department shows a total of 1,634 days without a lost time case and 3,438 days without an over seven-day case.

Riggers. The Accident Prevention Record for this department shows a total of 291 days without a lost time case and 864 days without an over seven-day case.

Gas Engines. The Accident Prevention Record for this department shows a total of 422 days without a lost time case and 2,088 days without an over seven-day case.

Electrical. The Accident Prevention Record for this department shows a total of 1,516 days without a lost time case and 3,235 days without an over seven-day case.

Masons. The Accident Prevention Record for this department shows a total of 2,014 days without either a lost time or over seven-day case.

Roll Shop. The Accident Prevention Record for this department shows a total of 2,697 days without a lost time case and 4,196 days without an over seven-day case.

Boilers. The Accident Prevention Record for this department shows a total of 1,160 days without a lost time or over seven-day case.

Yard Department. The Accident Prevention Record for this department shows a total of 665 days without either a lost time or over seven-day case.

Foundry. The Accident Prevention Record for this department shows a total of 441 days without either a lost time or over seven-day case.

Roll Foundry. The Accident Prevention Record for this department shows a total of 2,401 days without either a lost time or over seven-day case.

A.I.&S.E.E. Inspection Trip Westinghouse E. & M. Co., February 3rd 1928

TWENTY-ONE years ago, at East Pittsburgh, Pa., sixteen steel mill engineers assembled as guests of the Westinghouse Electric and Manufacturing Company to discuss the advisability of close co-operation of the engineer in the field with the designing engineer and manufacturer. The far reaching significance of such co-operation became so immediately evident to these engineers from the field that they conceived the idea of organizing a society mainly for the purpose of furthering the development of the application of electricity to steel mill requirements by close co-operative effort. During the twenty-one years since the organization of the A. I. & S. E. E. the organization has grown from a membership of sixteen to a membership of more than 1500, from a handful of energetic pioneers to one of the largest and strongest industrial associations in America.

Now, after twenty-one years, the Association of Iron and Steel Electrical Engineers have again assembled at East Pittsburgh, Pa., as guests of the Westinghouse Electric and Manufacturing Company, to again discuss the mutual problems of the steel industry and the electrical manufacturer, and to again review the significant developments in the field of electrical engineering. But the assemblage of February 3, 1928, consisted of more than two hundred twenty-five members of the association, and these members were not only from the Pittsburgh district, but from Chicago, Wheeling, Cleveland, Youngstown, Buffalo, Baltimore, Bethlehem, Cincinnati and Philadelphia, and, after twenty-one years, five of the twelve charter members of the association were again present, namely Mr. R. B. Davenport, Mr. James Farrington, Mr. O. R. Jones, Mr. Geo. H. McFeaters, and Mr. John C. Reed.

The purpose of the inspection trip of February 3, was to obtain a broader understanding of the manufacturing methods and research developments of an electrical manufacturing company. During the day the members of the association were greatly impressed by the rapid and significant development that is being made in almost every branch of the electrical industry. Many and various exhibits throughout the shops demonstrated the latest designs of apparatus such as brakes, welding sets, Diesel-electric locomotives, switch gear, and motors. In addition to an inspection of the works, the day's program included a visit to the research laboratory, where the visitors were given a brief picture of the latest practical developments in the fundamental science of physics and chemistry. The visitors were entertained at a luncheon and with a dinner, as the Association program included the presentation of papers and discussions after the inspection trip. Papers presented at the technical session on the subject, "Does Grounding the Neutral Prevent Apparatus Trouble," included representation from the manufacturing companies, public service companies, Bell Telephone Company and the steel industry. The technical program was as follows:

"Theory of Grounding," by P. C. Hanker, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

"The Effect of Grounded Neutral on the Efficiency of Lightning Protection Equipment," by K. B. McEachron, General Electric Company, Pittsfield, Mass.

"The Effect of Grounding on the Reliability of Relay Operation," by E. A. Hester, Duquesne Light Company, Pittsburgh, Pa.

"Experience with Grounded Neutral in a Public Utility," by Geo. S. Humphrey, West Penn Power Company, Pittsburgh, Pa.

"Effect of Grounding on Telephone Interference," by J. J. Pilliod, Engineer, American Telephone & Telegraph Company, New York.

"Experience with Equipment when Operating with Neutral Grounded in Steel Mills," by A. C. Cummins, Elec. Supt., Carnegie Steel Company, Duquesne, Pa.

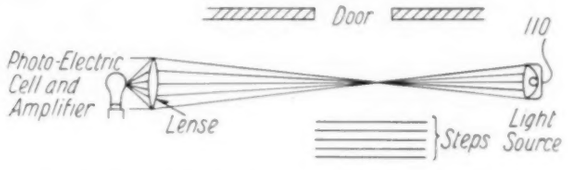
RESEARCH POINTS TO MAJOR CHANGES IN METHODS

Research departments set the pace of progress in all industry. Whereas the design departments and those departments specializing on the choice and improvement of materials are concerning themselves largely with the problem of doing better what is already being done, research departments are searching for new processes and new methods. Those prophets who project wisely into the future do so on the basis of what is being done in the research laboratories. The following descriptions of research developments are intended to give the essential trends in the different fields of practical scientific development.

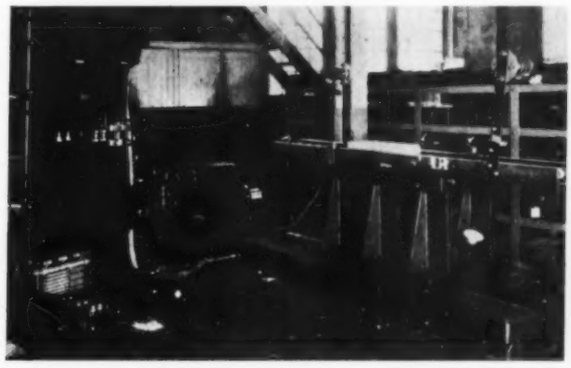
PHOTO ELECTRIC CELL

As a novelty there was set up at the entrance to the office building a counting device making use of a photo-electric cell. The members of the Association were automatically counted as they entered

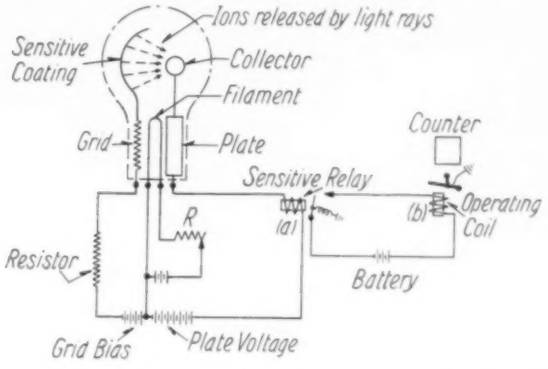
the building by casting their shadows on the photo cell, which actuated a relay, which in turn operated a counting mechanism. This furnished an example of one of the many uses of the photo-electric cell. In the control exhibit two of these cells were used as flag switches. This exhibit consisted of a roll



table, two photo-electric cell flag switches, one at either end of the roll table, a motor, and an Inductive Time Limit control panel. Each flag switch consisted of a spot light, placed under the rolls of the roll table, and a photo-electric cell, placed about two feet above the roll table. The light from each spot light was directed between two of the rollers on the table onto the photo-electric cell. A two-



by-ten-inch board was placed on the table so that as it moved along the table it interrupted alternately the beams of light. As one of the beams of light was interrupted the photo-electric cell actuated a



relay which reversed the motor. Thus the board automatically ran back and forth across the roll table. A typical circuit using the photo-electric cell is shown herewith.

TIME LIMIT CONTROL OF MOTORS

Mr. Newill, manager of the Control Engineering Department of the Westinghouse Company, described in an illustrated talk the time-limit method of starting mill motors as follows:

"The present trend of control for motors driving mill auxiliaries is toward forced acceleration by the use of time-limiting relays, and away from current-limit acceleration. Forced acceleration is now practicable because motors are now built to stand more mechanical abuse than formerly, and because motors do not now reach their limits of heating and commutation so quickly as formerly. Thus it is unnecessary to limit current peaks, and the problem of properly driving the load is given first consideration."

The Westinghouse Electric and Manufacturing Company has developed a new form of inductive time limit accelerating relay to accomplish forced acceleration.

The relay, as shown in (Figure 1,) is made substantially without moving parts or points of wear. It is an individual unit which can be

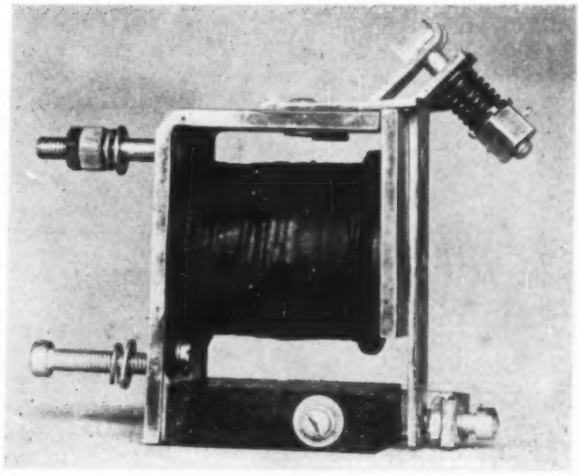


FIG. 1.

mounted and operated without fitting various parts. It has discarded non-magnetic shims in the air gap and uses a demagnetizing coil to overcome residual magnetism to assure drop-out. Its adjustment, varying its time period from one-half second to two seconds, is accomplished by changing the compression of the spring. It is significant that by eliminating the residual magnetism non-magnetic shims to assure drop-out are no longer necessary, and because the flux in the magnetic circuit dies down to zero higher spring pressures may be used to open the relay. The results of these features are freedom from trouble due to vibration, dirt, changing load, variation in voltage, or change in temperature.

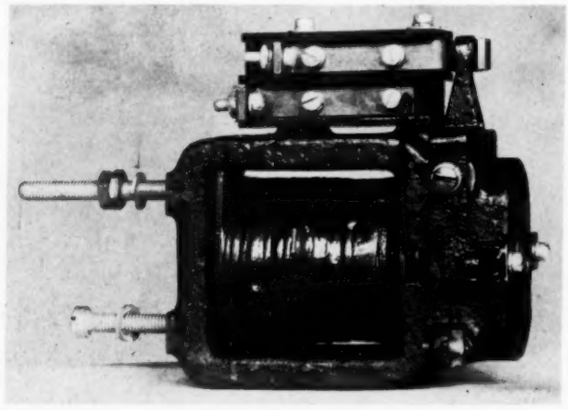


FIG. 2.

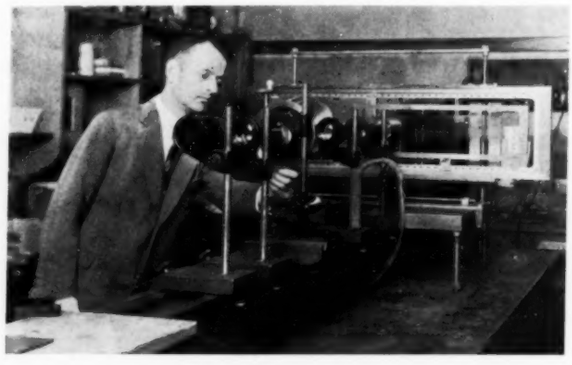
A relay to take care of pluging (shown in Figure 2) has also been developed. The rotation of the motor is the only factor which should influence a plugging relay, and this performance has been accomplished in the Westinghouse device. A polarized relay is used, having one coil energized across line voltage with its polarity unchanged. In the field of this coil is a movable coil which is connected across the counter voltage of the motor's armature, and this responds accurately to the rotation of the motor. The plugging relay establishes the circuits for forward rotation of the motor when the motor is rotating forward whether driven from the line or coasting. Correspondingly, the relay establishes the circuits for the reverse operation of the motor at all times its armature is rotating in the reverse direction. This relay is an individual unit, and requires no adjustment.

PHOTO STRESS ANALYSIS

Most spectacular of the exhibits of February 3, was Mr. Baud's demonstration of photo stress analysis of structural numbers too complicated in shape for mathematical analysis. Mr. Baud's apparatus consists essentially of a lantern for producing a beam of white light, two nicol prisms, a sample of transparent material the stresses in which are to be studied, and a screen on which is thrown an image of the transparent sample. The light from the lantern first passes through a nicol prism which polarizes the light in a vertical plane. This polarized light then passes through the transparent sample being studied, and thence through a second nicol prism which polarizes the light in a horizontal plane. From the second nicol prism the light passes to a screen on which is cast an image of the sample. If the sample were not inserted between the two nicol prisms, no light would pass to the screen, but when the light passes through the test sample it (the light) is divided into two planes, both of which are at an angle to the vertical, thus producing a horizontal component of light to be emitted through the second nicol prism and onto the screen. When the sample is stressed, the image on the screen turns different colors, each color corresponding to a certain intensity of stress. Portions not stressed at all remain black, whereas the stressed portions may be gray, or yellow, or red, or green, depending on the intensity of stress. These colors usually form themselves into concentric rings, gray being the band of least stress and green being the band of greatest stress. As the stress is increased these bands repeat themselves in the same order as already given, and each repeated band represents a stress twice as great as the first band of the same color. It is assumed that stresses in steel members of the same shape as the transparent test sample will distribute themselves the same as in the test sample. Tests have shown that this is a correct assumption, provided the proportional limit is not exceeded.

From the description already given it is apparent that on the screen of Mr. Baud's machine is given a color map of the stresses in the test pieces. The next step in stress analysis is to measure the magnitude of these stresses. This is done as follows:

There is inserted between the Nicol prisms two samples, one of complicated shape and one of simple shape. The simple test piece is of rectangular cross section so that the unit stress can be easily computed. The complicated test piece is then stressed until the color bands appear. Now if it is desired to measure the intensity of stress represented by the green color, the simple test piece is loaded until the stress in it is represented on the screen by green. The unit stress of the simple test piece is then computed, and this unit stress represents also the unit stress in the portion of the complicated sample which casts a green image on the screen.



KNOWLES GRID GLOW TUBE

Applications requiring an ultra-sensitive relay are now making use of the grid-glow tube, an invention of Mr. D. D. Knowles of the Westinghouse Research Department. A current flow of less than one millionth of an ampere is required to operate this tube. In the exhibition of February 3, Mr. Knowles demonstrated the action of the same grid-glow relay set that was used last spring to start the Homestead Steel Mill by the wave of the late Judge Gary's hand toward a crystal ball that was placed on his office desk in New York. In the starting of this steel mill the closing of the relay in New York closed a circuit which sent out short wave radio impulses which were picked up by a short-wave receiver in Pittsburgh, and which in turn closed the circuit-breakers at Homestead. This exhibition was in connection with an Inspection Trip of the Association of Iron & Steel Electrical Engineers to the Homestead Works of the Carnegie Steel Company, June 16, 1927, at which time about 1,100 members and guests of the Association inspected the new structural mills at Homestead.

Practical applications of the grid-glow tube are numerous. It is now being used in the Televox, making possible the use of vibrating reed relays. Recently in New York an automobile dealer applied one of these sensitive relays to start and stop an automobile in his show window by a person on the street bringing his hand near a small circle painted on the window. The field of application of the

grid-glow tube will be appreciated in the light of the fact that this relay is ten thousand times as sensitive as a standard telephone relay.

PHOTO-SENSITIVE CELL

Mr. Knowles described also the closing of relays by the use of photo electric glow cells. Such a relay set was used to count automatically the members of the A. I. & S. E. E. inspection party as they entered the reception room of the Westinghouse Works, and another set was used in a flag switch application in the control exhibit already described.

Important characteristics of the photo-electric glow tube are its sensitivity to variations of light and its quickness of operation. Experiments show that when the cell is connected to a sixty-cycle source of supply it will operate a relay in one one-hundred-twentieth of a second. To test the quickness of operation the open hand was chopped across the beam that was directed on the cell so that the four fingers would cut the beam in succession. When the hand was allowed to fall of its own weight across the beam, the relay responded positively to the shadow of each finger. So sensitive is the cell to variations of light that the shadow caused by the sun's passing behind a cloud is more dense than is necessary to actuate the relay. This is a variation of the order of five foot-candles.

Such applications as automatically turning on lights as darkness draws on, counting automatically, and closing flag-switches are immediately suggested. The cell is also being used to prevent the repetition of flashovers on D.C. motors and generators. Another application now being considered is the control of ventilation of vehicular tunnels by automatically recording the number of cars in these tunnels. A steel plant engineer has suggested the use of this cell to prevent the collisions of overhead cranes with each other and with abutments. Such a tube can be used to warn an operator automatically when smoke has reached a certain density in any place, although for this particular purpose another tube has been developed which is more satisfactory because of its quality of recording the density of smoke at all times instead of merely closing a relay when the smoke reaches a certain pre-determined density.

HIGH FREQUENCY TESTING OF MOTOR COILS

Testing of motor coils by the use of high frequency voltage is significant from the standpoint of better testing, and from the standpoint of improved motor design. But why use high frequency for testing, it will be asked, why isn't the 60-cycle test sufficient?

It is relatively simple to test the strength of insulation between a motor coil and the frame of the motor by the use of a 60-cycle supply because this path between the coil and the frame is a non-conducting path, and there is no passage of current. But to test the insulation between turns of wire in a coil requires a different method because as soon as a voltage is impressed across the terminals of the coil a current will flow, and the coil reaches its current-carrying capacity long before a test voltage is obtained. Thus such a test requires the use of high frequency voltage because this is the only way of obtaining a high voltage without getting excessive current. Furthermore, the low current present in this high frequency test makes it possible to locate the exact point of insulation failure when failure occurs. Two advantages are derived, then, by testing with high frequency, first, a complete insulation test is obtained, and second, weakness in design are immediately located and corrected.

It is a fact that since the inception of high frequency testing in the Westinghouse shops, failures of machines in the field due to faulty insulation have become so rare as to be negligible.

TELEVOX

The "Televox" is a device for controlling small distributing sub-stations, or other remote equipment, through the medium of an ordinary telephone connection. This machine actually answers the telephone by lifting the receiver, and in effect carries on a conversation with the person who makes the call. It does not speak English, but its language is one of whistles and buzzes that can be readily learned by anyone. The equipment demonstrated on February 3 is a five-position device, and for purpose of demonstration was connected with a fan, a motor, a horn, and two lights.

Upon calling the equipment over the telephone system any of these devices could be started or stopped at will, by the manipulation of the proper whistles from the distant 'phone. Through the medium of a buzzer code the receiving equipment reported to the dispatcher just what switching was done.

Sound-sensitive relays are tuned each to a different frequency. Each of these relays has a steel reed, which will close the relay contacts only when it is vibrating at its natural frequency. Connected to these reeds are the Knowles grid-glow tubes which operate the rest of the equipment. The illustration shows the telephone answering equipment on the left in which the standard desk 'phone is located, with the selective relay equipment in the larger frame on the right.

By the use of this equipment any form of remote operation with corresponding answering signals can be obtained through the standard telephone exchange system as freely as ordinary conversation can be carried on.

INDUCTION FURNACES

Although induction furnaces have been in use for a long while, the use of high frequencies for heating small amounts of metals to high temperatures is relatively new. The high-frequency induction furnace developed by Dr. Northrup and patented by the Ajax Electrothermic Corporation, is used to melt steel in a vacuum in the absense of carbon thus making it possible to obtain melts of pure metal. Another furnace that operates at 10,000 cycles has a capacity of sixty pounds of steel. The maximum temperature of this furnace is determined by the melting point of the refractories, which is in this case between 1600 and 1700 degrees Centigrade. A small, high-frequency furnace has been developed which will attain a temperature above that of the melting point of tungsten. (3000°C). This furnace is lined with a special refractory of graphite and sugar charcoal. It operates at 20 KW and 5000 cycles, and has a capacity of about seven pounds of metal. It should be borne in mind that these furnaces are far beyond the stage of laboratory toys. Many of them are in commercial use.

For large-scale work 60-cycle furnaces have been developed. In construction these furnaces consist essentially of a crucible around which is a water-cooled coil for producing the induced currents in the metal. In these new furnaces the iron ore essential to the conventional ring-type induction furnaces is unnecessary. One of these furnaces now in use in a brass foundry melts 500 pounds of metal an hour and draws a maximum of 120 KW. from the line. These furnaces have been used for melting pure iron, iron-nickel alloys, and other alloys containing high chromium content. Similar furnaces are likewise used to heat salt baths for heat-treating steel. Temperatures for such furnaces are usually between 1300 and 1400 degrees Centigrade.

TESTING OF METALS AT HIGH TEMPERATURES

As machine design tends toward the use of higher and higher steam pressures, materials are called upon to operate at higher and higher temperatures. Refinements of design have made deformation the determining factor in the selection of steel rather than ultimate strength and careful research has shown that the deformation of steel at high temperatures depends largely on the amount of time the steel is stressed. Research also shows that steel of otherwise good quality may scale at high temperatures, thus decreasing the cross section and increasing the deformation. Again the length of time the piece is under test is of primary importance, because in many cases the tendency to scale does not manifest itself until the piece has been under test for a long time. It is generally understood that increasing the stresses of machines by increasing centrifugal forces introduces dangers that require more careful designing, but it is not so well understood that increasing the temperature under which materials must operate may introduce dangers more iminent than those incident to increased speed. Equipment for long time testing of steel at high temperatures is now in use by manufacturers, and by the use of this equipment the selection of high grade steel is being made on the basis of new and more rigid standards.

RECTOX

Rectox is the simplest type of current rectifier yet built. For trickle charger service it consists of a transformer, which steps the voltage down from 115 volts to 17 volts; and a stack of oxidized copper rectifying discs, which convert the alternating current into direct current. These discs are alternately lead and copper, one side of the copper discs being oxidized. Due to an electronic action current will not readily flow from copper oxide to copper but current will flow readily from copper to copper oxide. For full wave rectification a bridge circuit is used which devides the rectifying discs into four parts, half of the discs allowing current to flow to the battery during the positive half of the wave, and the other half of the discs allowing current to flow to the battery during the negative half of the wave.

At present Rectox is being applied mainly as a trickle charger for radio A-batteries. In this application the rectifier charges at a constant rate of three-fourths amperes. Developments are being made to apply copper oxide rectifiers to rectification of higher currents. Already a current flow of five amperes is being rectified experimentally. There is an application for Rectox where ever there is an application for a storage battery. Experiments indicate that the rectifying discs will last a very long time without serious deterioration.

A CARBON BRUSH XYLOPHONE

So important are carbon brushes to the correct operation of electrical machines that much time and money is spent in testing for the highest quality of brush material. Rigid tests of carbon brushes take into account such factors as porosity, the content of iron and graphite, specific resistance, mechanical strength both under steady stress and repeated impact, temperatures and moisture conditions, contact voltage drop, and the effect of current flow on these factors. It has been discovered that the tone emitted when a block of carbon is tapped with a hammer has a direct relation to the number of impacts necessary to break the sample. This test induced Mr. Little to construct a Xylophone consisting of carbon blocks all of the same dimensions. The natural frequency of vibration of these blocks is a function of the quality of the block and not of its physical dimensions. The physical strength of the samples vary directly with the frequency of vibration when the samples are tapped with a hammer; that is, a block emitting a high tone withstands a greater number of impacts than one emitting a low tone. Another interesting phenomenon observed in testing carbon brushes is that the abrasive action of the carbon running in

contact with the commutator is greatly increased when current flows across the contact surface. The reason for this is yet unknown, but the fact is evidently an important one in testing brushes.

STEPS TOWARD RADIO POWER TRANSMISSION

By the use of a closed electric circuit two meters long Dr. Thomas has demonstrated the distribution of current and voltage when the current in the circuit is of short waves. It was shown that at the middle of this loop no current flowed, and that at the ends the current was at its maximum value, which indicates that the current flowed from the center outward. To show that considerable power passed around the circuit in this manner Dr. Thomas connected 110 volts direct-current to the same circuit and the lamps in the circuit glowed only faintly, whereas the lamp at the end of the loop glowed brilliantly when the short wave current was induced in the loop.

Engineers generally agree that to transmit very much power over the air it will be necessary to direct the radio waves in a beam. Short waves will be necessary for this beam because the reflector must be at least one wave-length in diameter, and to be efficient, should be produced several wave-lengths in diameter.

NEW METHOD OF INSULATING FOR HIGH VOLTAGE

The trend in electric power generation is toward higher voltage, which requires improved methods of insulating the windings of generators. Generation of power at high voltage ceases to be economical when corona becomes excessive, hence, the problem of the engineer is to reduce corona. Dr. Hill demonstrated a new method of insulating the coils of turbo-generators which will make it possible to generate power at 22,000 volts with no more corona than is now present in generators working at 13,000 volts. By this new method of insulating there is added to the insulation now used a coat of graphite paint, which is grounded to the laminations of the stator, and at the ends of each stator coil is placed several inches of high resistance insulation, the purpose of which is to increase the resistance to the condenser currents that tend to flow from the end of the stator slot to the stator coil.

NEW METHOD OF ABSORBING VIBRATION OF MACHINES

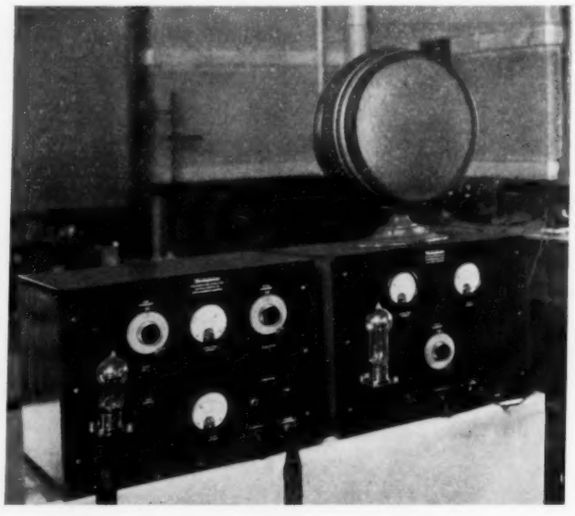
Recently the vibrations in a 35,000 KW. turbine were completely eliminated by attaching a twenty-inch cantilever beam to the base of the machine and placing a twenty-five pound weight at the end of the cantilever. Experiments indicate that almost any vibration can be eliminated by this Dynamical Vibration Absorber. In general this absorber consists of several small vibrating systems tuned to the speed of operation of the machine that is vibrating. On February 3, Mr. Stone demonstrated the absorber on a half horse-power motor that had been thrown out of balance by short cranks on the shaft. The motor was fastened to a flexible beam, which vibrated violently when the motor was brought up to the critical speed of this beam. Two weights placed at the end of cantilever beams were then attached to the base of the motor, and when the motor was again brought up to the critical speed no vibration was imparted to the beam, all of it being absorbed by the two weights attached to the motor base. To absorb the vibrations of variable speed machines the small cantilever beams are damped.

EXPONENTIAL RADIO AND PHONOGRAPH HORN

Developments to improve the transmission of music remind us that the underlying purpose of all research is to enrich life. This purpose is evidently furthered by a device that brings good music to the ears of people who do not have private radio sets. New developments in horns is making it possible to reproduce music at great volume without loss of quality.

The exponential horn, developed by Dr. Slepian and Mr. C. R. Hanna of the Westinghouse Research Department, derives its name from the fact that its curve is, in mathematical terms, that of an exponential function. More simply the exponential horn is one the area of cross section of which doubles at equal intervals along its length. To reproduce tones as low as 64 vibrations per second without noticeable air column resonance and at high volume the horn should be constructed so that the area of the throat is small and the effective diameter of the mouth of the horn is on the order of one-fourth of the wave length of the lowest notes emitted. Thus a horn that reproduces notes as low as 64 vibrations per second and which doubles in area for every foot of length will be about four feet square at the mouth, or four and a half feet in diameter if a circular cross section is used. The reason for making the throat of the horn of small cross section is so that a small diaphragm will set in motion the large volume of air in the horn.

With the exponential horn it is possible to reproduce Sousa's Band with all instruments from drums and tubes to piccolos and flutes at full volume, or the 2500 voices of the Associated Glee Clubs of America singing to full organ accompaniment without the slightest rattle or overloading of the diaphragm. When this horn is put into general use it will be unnecessary to travel to big cities to



hear a famed symphony orchestra or go to the large moving picture theatre to see a picture accompanied by an organ score played by an acclaimed musician. Such music will be reproduced in local auditoriums or theaters.

CHROMIUM PLATING

Chromium, a metal that will scratch glass, is now being plated by an electrolytic bath on iron, copper, and other metals. Variations in the hardness of the plate may be made by varying the temperature of the electrolytic bath, and by varying the plating current. Plating may be done to a thickness of from 3 to 5 thousandths of an inch. The plate has a high luster and does not crack when bent. Its co-efficient of expansion is such that wide variations in temperature do not cause the bi-metal combination to be distorted, or cause the plate to crack.

The possibilities of chromium plating may be appreciated in the light of applications that have already been successfully made. The high luster and hardness of the plate make it especially suitable for reflectors. Drills for cutting slate are being plated with chromium with a great increase in the life of the drills. Chromium plated gears meshed with steel gears are proving successful. It has been found that plating bearing surfaces with chromium reduces the necessary amount of lubrication. Chromium plated files are self cleaning when used on soft metals, such as brass and babbitt. Plug gauges are now being made by chromium plating up to size from two or three ten thousandths under size. The life of molds for micarta is greatly increased by chromium plating, due to the prevention of corrosion. A great advantage of chromium plated threaders for porcelain insulators is that when the plate wears down the tool may be put back into service by merely replating it.

COBALT STEEL MAGNETS

Cobalt steel magnets have attracted wide attention because of their unusual coercive force, this force being usually about five times that of ordinary magnet materials. For a given air gap flux-density, a cobalt steel magnet weighs from one-third to one-fifth as much as a magnet of ordinary steel. These magnets are applied where it is necessary to reduce weight. In this capacity they have made possible the portable oscillograph, the OSISO. In this application a cobalt steel magnet weighing less than one pound serves the same purpose as would be served by an electro-magnet and batteries weighing thirty-five or forty pounds. Cobalt steel magnets are applied also in various types of meters, and in electric pickups for phonographs. This material will be used on a new type of radio loud-speaker to reduce the size and weight. Under service conditions cobalt steel retains its magnetism much better than ordinary magnet steel, but costs about ten times as much as ordinary magnet steel.

INERTAIRE DEMONSTRATION

This demonstration is arranged to show the manner in which the Inertaire Compound, or Deox removes oxygen from the air breathed by transformers during varying load conditions. The material in the demonstration tube is a mixture of finely divided metallic copper, ammonium chloride and calcium chloride, with enough kieselguhr to render the mass porous. When the air passes through this mixture, the oxygen is all removed as shown by the fact that a candle in the air stream is snuffed out. In practice, the Deox is held in large glass jars on the side of the transformer, and all the untreated air is forced to pass through these jars, being robbed of its oxygen in the process. The result of keeping oxygen out of the transformer atmosphere is to prevent the formation of sludge and acid in the oil. A second feature is that in the absence of oxygen above the oil, any short within the oil, generating hydrogen and other inflammable gases, cannot result in a secondary explosion of these gases with oxygen.

CRYSTAL CONTROL OF FREQUENCY

Quartz is strained when it is subject to an electric field, and it is set into mechanical vibration when put into an oscillating electric field. Because of its very sharp resonance response radio engineers are making use of quartz crystals to control the frequencies of transmitted waves. The resonance peak of an ordinary radio circuit, comprised of a coil, condenser, and resistance is much less sharp than the resonance peak of a quartz crystal. In general the crystal peak is 500 times as sharp as that of an ordinary tuned circuit. This means that when a crystal is used for control, the frequency varies one five hundredth as much, under circuit variations as when the regular electrically tuned circuit control is used.

Every piece of quartz has several natural periods of vibration, corresponding to the dimensions of the crystal. When any crystal is placed in an oscillating electric field, that crystal will respond only to oscillations of the same period as one of its natural periods of vibration. Then a properly designed vacuum tube circuit of which a quartz crystal is the control element will oscillate at only one of the natural periods of vibration of the quartz crystal. For the present broadcasting bands the thinnest dimension of the quartz crystal is the oscillating dimension.

LONG ISLAND OIL-ELECTRIC LOCOMOTIVE EXHIBITED

The membership also had an opportunity to see the oil-electric locomotive about to be delivered to the Long Island Railroad. This locomotive consists of two cabs, each cab mounted on a 2-axle truck and powered with a Westinghouse-Beardmore, 300 H.P. oil engine. This engine is unique in that it is the first modern high speed oil engine applied to this type of service and is made up of light-weight high-grade material parts resulting in an engine which, complete with flywheel, weighs only 23 pounds per horsepower.

This oil engine drives a Westinghouse direct current generator feeding current to two traction motors mounted on each of the two axles. Each unit of the locomotive is capable of exerting a maximum tractive effort of approximately 23,000 pounds. This double unit locomotive is to be used in yard and switching service on the Long Island Railroad.

Locomotives of this type are of particular interest to all railroads and industrial plants for switching service due to their extreme flexibility of operation, their low cost of maintenance and operation and their high availability factor. It is safe to say that a locomotive of this type in yard service will be available for service no less than 22 hours per day, contrasting very favorably with the steam locomotive where a large portion of time is always consumed in taking on coal and water, cleaning fires, washing boilers, etc. One of the outstanding features of this locomotive is the type of control employed by means of which the speed and tractive effort of the locomotive is automatically controlled to meet the requirements of the immediate service and furthermore, so arranged that it is impossible to overload the oil engine. From the engineer's point of view, his only operation is that of advancing his throttle lever on his controller similar to his throttle on a steam locomotive, throw his "Johnson Bar" to set up either forward or reverse operation and apply his airbrakes in the usual manner. The operation has been made so simple that any steam locomotive engineer can quickly accustom himself to the operation of this unit.

As the result of experience already gained operating this unit in yard service, it can safely be said that on an hour for hour basis due to the greater flexibility and ease of handling and the quicker pick-

up of this unit, far more switching work can be done with this type of locomotive than with a similarly powered steam engine. Coupled with this the previously mentioned high availability factor makes it seem probable that at least two and in some cases as high as two and one-half steam locomotives can be replaced by one of these oil electric units.

CONCLUSION

Mr. A. J. Standing, President of the Association of Iron & Steel Electrical Engineers, stated at the dinner given in the evening that the visit was one of the most interesting and instructive trips that the Association has ever made, and that he thought the amount of ground which they were able to cover was due to the splendid arrangement and preparation that had been made to take care of such a crowd, and the splendid way in which these plans were executed. He also stated that the visit to the Research Laboratory was of unusual interest, as it indicated in a number of specific ways the broader phases of research work and demonstrated the amount of effort and attention that is being given to the broader phases of development work. The committee in general charge of arrangements consisted of Mr. W. E. Miller, Electrical Superintendent, Bethlehem Steel Co., Johnstown, Pa., who was general chairman of the inspection trip and technical session; Mr. J. R. Doyle, chairman, Publicity and Transportation; Mr. A. Stewart, Electrical Engineer, Pittsburgh Steel Co., Monessen, Pa., chairman, Papers; Mr. Brent Wiley, Assistant to Industrial Sales Manager (Toastmaster of the dinner) assisted by Mr. C. B. Stainback and Mr. T. E. Simpers of the Westinghouse Electric and Manufacturing Co., at East Pittsburgh, Pa.

Items of Interest

The General Electric Company announces a fully automatic control equipment for use with dynamometers in testing internal combustion engines. Although a great deal of this work is in the nature of research, requiring very close, accurate control of both armature and field, it has been found that the usual manual type of control can now be superseded by the automatic type.

The new control equipment consists of two panels, one a control panel and one a master panel. This arrangement permits mounting the master panel on the dynamometer base, providing complete control of the dynamometer at the point where the testing is being done. The automatic control panel, with its motor-operated rheostats and absorption resistor, is mounted at any suitable, remote place.

The automatic control panel has a motor-operated armature dial switch and a motor-operated field dial switch. The control is designed to allow an inrush of 2,000 amperes, a current which is sometimes necessary in starting a "stiff" engine. The armature dial switch is of a screw type, having a large number of staggered steps arranged for armature regulation up to the maximum rated current when the dynamometer is operated either as a motor or a generator. When acting as a motor, the armature and field switches operate in proper sequence in either direction. They return automatically when the dynamometer is stopped.

On overloads, the line contactor opens and a relay shuts off the ignition of the engine to prevent it from racing when the load is removed. As practically all dynamometers are separately excited, another relay shunts off the ignition in case of dynamometer field failure, preventing the engine from racing. It is customary, when running the dynamometer as a generator, to pump back on the line but, in case the user prefers to pump on the load resister instead, this can be accomplished by opening the line contactor and closing the load resistor contactor by means of a push button on the master panel.

The master panel is equipped with a field reversing switch and several push buttons, thus providing for the starting and stopping of the apparatus as well as for the control of the motor-operated armature and field resistors on the automatic panel. A vernier field rheostat, also mounted on the master panel, provides fine adjustment after the motor-operated field rheostat has brought the speed or load approximately to the value desired. A voltmeter and ammeter in the line provide complete indication of voltage and current under all operating conditions.

These panels are being built in 100 and 150 horsepower capacities. Panels having the same features, but with relatively larger parts, are also being built in capacities up to 400 horsepower.

At the annual directors meeting of the W. A. Jones Foundry & Machine Company of Chicago, held January 30, 1928, several changes were made in personal of the officers. The following will now direct the affairs of the company:

Warren G. Jones, President; George W. Page, Vice President; William F. Coleman, Treasurer; John A. Sizer, Secretary.

Mr. Warren G. Jones continues as President and General Manager.

Mr. G. W. Page, who assumes the position of Vice President, has been with the company for almost 30 years and is Director of Purchases.

Mr. William F. Coleman, the new Treasurer, is an old employee of the company and also holds the position of General Superintendent.

Mr. J. A. Sizer succeeds himself as Secretary. He, too, has been with the company for many years in the capacity of Office Manager.

The Board of directors consists of the following:

W. G. Jones, J. A. Sizer, G. W. Page, W. F. Coleman, W. A. Jones.

The Westinghouse Electric and Manufacturing Company has developed a new line of bus-bar supports known as the Modified Hollow Square type. These supports consist of heat-treated aluminum

(Continued on page 144)

FUEL SAVINGS CONFERENCE

Auspices

COMBUSTION ENGINEERING DIVISION

Association of Iron & Steel Electrical Engineers

Edgar Thomson Plant,
Carnegie Steel Co.,
Braddock, Penna.

Thursday,
March 29th,
1 9 2 8.

PROGRAM

9:30 to 10:00 A. M.—Assemble at Main Office, Edgar Thomson Works of Carnegie Steel Co., Braddock, Pa.

10:00 A. M.—"INSPECTION TRIP." This trip will include visits to the Blast Furnaces, Open Hearths, Finishing Mills, Boiler Plant and Sub-Stations.

MAIN FEATURE

NEW BOILER PLANT INSTALLATION

Consisting of

Blast Furnace Gas Fired Boilers
Coal Fired Boilers
Coke Breeze Fired Boilers

1:00 P. M.—Luncheon in Main Dining Room of Edgar Thomson Works of Carnegie Steel Company.

2:00 P. M.—Technical Session at Main Dining Room.

Subject:

"DRY QUENCHING OF COKE"

by Col. H. B. Savage.

Discussion led by Messrs. Walter Sennhauser and A. M. Beebe.

"POWDERED COAL APPLICATIONS TO INDUSTRIAL FURNACES"

by W. B. Shoudy, Asst. Prof. Mechanical Engineering, Columbia University.

Discussion led by Messrs. Henry Kreisinger and A. B. Wolfe.

After the presentation of the papers and the discussions by Messrs. Sennhauser, Beebe, Kreisinger and Wolfe, the meeting will be open for any general discussion which you might care to have prepared for the session. All papers and discussions will appear in the Iron and Steel Engineer, official organ of the Combustion Engineering Division of the A. I. & S. E. E.

MARTIN J. CONWAY, Chairman

W. J. HARPER	H. C. SEIBERT	A. G. WITTING
G. R. McDERMOTT	F. E. LEAHY	J. C. ALLEN
F. G. CUTLER	A. STEED	W. N. FLANAGAN
E. W. TREXLER	C. H. HUNT	L. C. EDGAR
	A. J. BOYNTON	

Admission by invitation only. Write to Association of Iron and Steel Electrical Engineer, 705 Empire Building, Pittsburgh, Pa.

alloy clamps which are insulated from the standard 1¼" pipe of the mounting support by means of high-grade micarta tubes. The bus support is designed for 4"x¼" bus-bars and for a maximum of 4000 volts a-c. or d-c.

The support may be adjusted to carry 1 or 12 bars. This feature allows the bus to be tapered as feeders are tapped off or allows the easy installation of additional bus copper to provide for an increasing load. The hollow square arrangement of bars will minimize the influence of both skin effect and proximity effect, and will allow the copper to be used at its maximum efficiency. The Modified Hollow Square bus-bar supports are particularly adapted to heavy low-voltage bus construction.

A line of squirrel cage induction motors suitable for starting on full line voltage is being placed on the market by Allis-Chalmers Manufacturing Company. These motors are normal torque, high reactance machines and will not draw starting current in excess of the limits recommended by the Electrical Apparatus Committee of the National Electric Light Association. They are built in ratings 7½ to 30 HP., 600 to 3600 RPM., low voltage, and are available with either sleeve or roller bearings. All superior features of Allis-Chalmers construction as employed in squirrel cage motors are maintained in this new line. A magnetic switch with push button control is the only starting equipment required.

The Reliance Electric & Engineering Company has just issued a very attractive bulletin No. 202, which describes Type T Heavy Duty Motors for Direct Current with Ball and Roller Bearings.

The subjects discussed in this bulletin are experiences with anti-friction bearing motors. Under the caption "Advantages of Anti-Friction Bearings" cleanliness and reduction of maintenance costs are discussed at some length. Mountings of Anti-Friction Bearings is also very ably treated as well as Enclosed Dust Tight and Water Tight Motors.

The Reliance Electric & Engineering Company located on Ivanhoe road in Cleveland, Ohio, will be glad to mail bulletin No. 202 to any one requesting it.

The Harnischfeger Sales Corporation has just issued a crane bulletin No. 450 which is a story of P. & H. Crane Construction. The bulletin contains 38 pages and contains real information in connection with the Crane Construction.

The Harnischfeger Corporation located at Milwaukee, Wis., will be pleased to mail the bulletin on request.

The Pittsburgh Transformer Company subsidiary of Allis-Chalmers Manufacturing Company, has issued a pamphlet describing the Subway Type of transformers. The bulletin is known as No. 2072 and will be mailed on request.

The Combustion Engineering Corporation has just issued a most attractive catalogue known as No. 2-DQ. It is the first comprehensive presentation of the Sulzer System for Dry Quenching of Coke. This equipment is manufactured by the Dry Quenching Equipment Corporation, a subsidiary of International Combustion Engineering Corporation, and is applicable wherever the quenching of hot coke is a problem. Its advantages over the wet quenching method in general use are manifold. The principal advantages are given on page nine and described in detail in the pages that follow. The economies to be derived are illustrated by specific examples on pages 26, 27, 28 and 29.

The by-product coke production of the U. S. in 1926 amounted to 44,376,586 tons. Of this, the total heat value of approximately 2,250,000 tons could be recovered and used for steam production if the dry quenching method were in general use. The fact that this enormous and needless waste is going on makes the adoption of dry quenching an economic necessity and establishes it as one of the most vital of present day industrial developments.

The Combustion Engineering Corporation located at 200 Madison avenue, New York City, will be glad to send the catalogue on request to those interested.

SALVAGE OF STEEL PLANT EQUIPMENT BY WELDING

(Continued from page III)

finish. The claim is made that this work can be done by means of automatic welding machines at a cost per wheel under the similar cost of a special composition or specially treated wheel.

Results can be obtained only after a certain amount of experimentation with various compositions; and comparison of the service records of welded jobs in tons produced or in some similar index expressed as percentages of new life. Use of this data is also the only fair way of tabulating the salvage value of the jobs completed and of estimating the justification for making expenditures necessary to recover equipment which has approached the limit of its useful life from causes other than the wear to be replaced. Notwithstanding the above mentioned tendency to over weld, I believe I am safe in saying that the welding section of the plant maintenance lay-out can be made to pay continually very satisfactory dividends on the original investment. This is especially true after the experimental stage has been passed and the welding operation is going ahead on a regular order and production basis with an occasional check up of results in life and wear of the recovered equipment that has been returned to service.

The various methods of welding that lend themselves most readily to repair work are the gas torch and the carbon and metallic electric arc. The carbon arc however is used mainly for rapid building up of large masses of metal.

When welding has once become an established procedure in a plant we find it is easier to reach out and enlarge the field of its activities. The recent developments and tests in the metallic arc and resistance welding of structural steel have opened up possibilities in building construction and repairs which we will take advantage of as welding gains the confidence of plant construction men.

There are doubtless many profitable uses of welding as a salvage method upon which I have not touched, but the above references will serve to illustrate the possibilities which justify the time and expense of developing in a plant competent welders who will be available for any type of work that may come up.

ASSOCIATION OF IRON & STEEL ELECTRICAL ENGINEERS

705 EMPIRE BUILDING, PITTSBURGH, PA.

QUESTIONNAIRE: ANTI-FRICTION BEARINGS FOR USE ON ROLL AND PINION NECKS

(To be referred to your Roll Designers and your Rolling Mill Superintendents)

Information and data secured will be compiled in a paper to be presented before the Iron and Steel Engineers at their Annual Convention and Iron and Steel Exposition being held at Stevens Hotel, Chicago, Ill., during the week of June 25th, 1928.

All replies should be addressed to the Association of Iron and Steel Electrical Engineers, 705 Empire Building, Pittsburgh, Pa., and should reach us, if possible, not later than March 30th.

Credit will be given or withheld in each instance, according to the wishes of the donor.

APPLICATION OF ROLLER BEARINGS TO ROLL AND PINION NECKS

1. What do you consider the chief limitation to the use of roller bearings for this service?

2. What disadvantages can you suggest in regard to such application?

3. Roller Bearings, consequently roll necks, can be cooled to about 250°F by an oil circulation system on the bearings.

   Do you thing such cooling would tend to cause neck breakage, particularly in the case of hot sheet mill rolls?

4. Will the fact that there is practically no wear on roller bearings, either transverse or longitudinal, eliminate any trouble in mill operation?

Will the elimination of wear both transverse and longitudinal in roll neck bearings prove to be of value to mill operation?

Will it help to roll more accurate products?

Will it lengthen the time beween roll dressing?

5. Have you ever made temperature tests on roll necks after a steady run on the mill?

6. If so, will you please give the results?

BACK-LASH

Back-lash presents quite a problem because its elimination by means of drags would materially reduce the power savings due to the use of anti-friction bearings.

7. Have you experienced any trouble from this source in the use of roller bearings?

8. If so, how was it corrected?

9. Do you think the ordinary coupling box fits will cause serious back-lash?

10. If so, would finishing wobblers and coupling boxes remedy the trouble?

What clearance would you use for such fits?

Would the life of the finished surfaces be long enough to warrant the expense?

11. Would you prefer universal couplings to finished boxes and wobblers?

NECKS

With the present practice in regard to the diameter of roll necks, it is frequently found impossible to apply roller bearings to two and three-high stands. To attempt to determine whether or not neck diameters could be reduced to permit the use of roller bearings without danger of neck breakage, your experience or opinions are requested in regard to the following:

12. What are the chief causes of neck breakage?

13. Is there any standard ratio between roll and neck sizes for various roll diameters?

14. Is the present diameter of necks in proportion to that of the rolls necessary to obtain torsional strength in the necks, or is to minimize the unit pressure on the bearings?

15. If power required for rolling can be reduced from 40 to 50% by the use of roller bearings, and if present neck diameters were necessary either for reason of torsional strength, or to obtain low unit bearing pressure, can neck diameters be safely reduced if roller bearings are used?

16. To what extent would such reduction be limited by the necessary diameter of the wobbler?

17. What effect does the radius of the fillet between neck and body have on the strength of the former?

18. What rule do you use to determine the radius of this fillet?

19. The point of application of roller bearing is closer to the body of the roll than in the case of standard bearings. Will this fact allow of a reduction in the diameter of the neck, and still maintain the desired strength?

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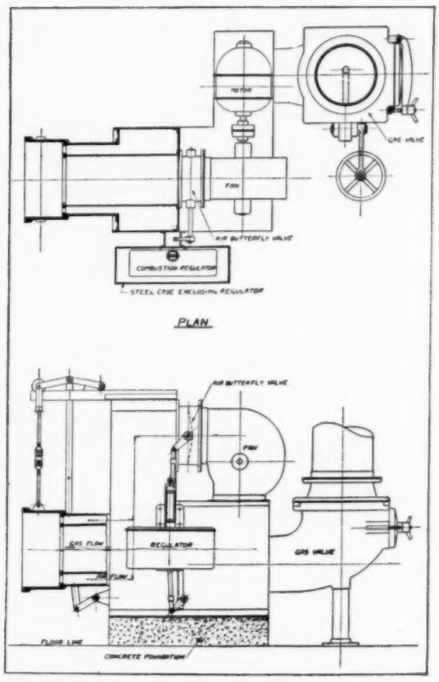

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